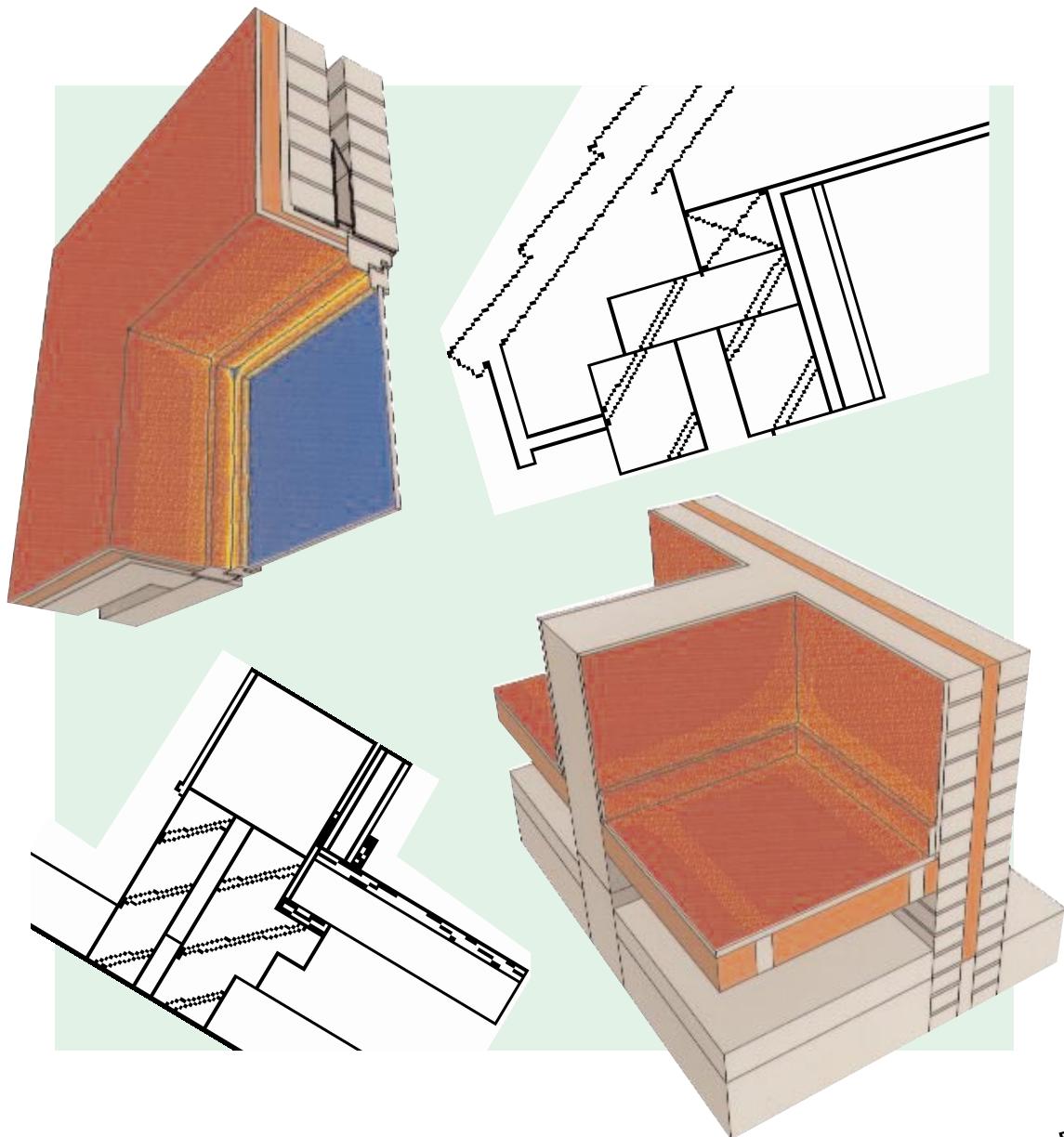


# Minimising thermal bridging when upgrading existing housing

A detailed guide for architects and building designers



ENERGY EFFICIENCY

BEST PRACTICE  
PROGRAMME

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# Introduction

This Guide is aimed at architects and building designers. It will also be of interest to builders and specifiers. The Guide examines six different forms of construction:

- solid brick walls
- traditional cavity wall construction
- crosswall construction
- concrete framed construction
- no-fines concrete
- large panel systems.

A chapter on timber framed construction has not been included in this Guide. The Guide concentrates on masonry construction systems because timber frame, when insulated, does not result in any significant thermal bridging problems. Where timber framed walls abut other elements of construction, follow the advice in Chapter 3, 'Crosswall Construction'. Chapter 4 of Good Practice Guide 174 (GPG 174), '*Minimising thermal bridging in new dwellings*' gives further advice, on timber framed walls.

Thermal bridges are areas of the fabric where, because of the materials used or the geometry of the construction, heat flows are higher than through the rest of the building. This results in a higher energy requirement for the building but, more importantly, the higher heat flow through the thermal bridge leads to lower internal surface temperatures and an increased risk of mould growth. This can have a much greater impact on energy consumption, as attempts are made to cure the mould by raising internal temperatures or increasing ventilation rates. Moulds are a major source of distress for householders and can cause respiratory and other allergies to sensitive people.

## Minimising thermal bridges

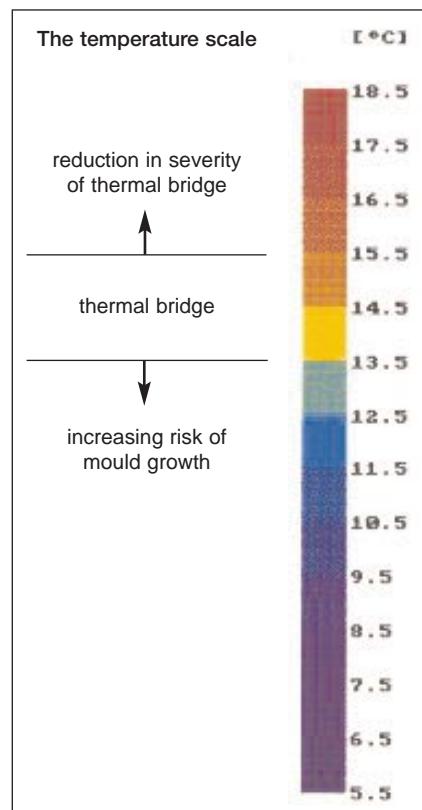
This Guide shows how, by careful detailing, thermal bridges can be minimised. A colour scale is used to represent surface temperatures. This highlights in a clear way the extent and severity of the thermal bridges.

Where surface temperatures are 13.5°C or less, coloured green and blue on the temperature

scale, there is a risk of mould growth given the humidities normally occurring in UK housing. Where surface temperatures are between 13.5 and 15.5°C, coloured yellow and orange on the temperature scale, a thermal bridge still exists, but is unlikely to result in mould growth with typical indoor humidities.

The temperature scale used for the three-dimensional illustrations is shown below.

In some cases the three-dimensional illustrations are supplemented by cross-sections or thermographs, which have their own temperature scale alongside.



# Introduction

## Assumptions

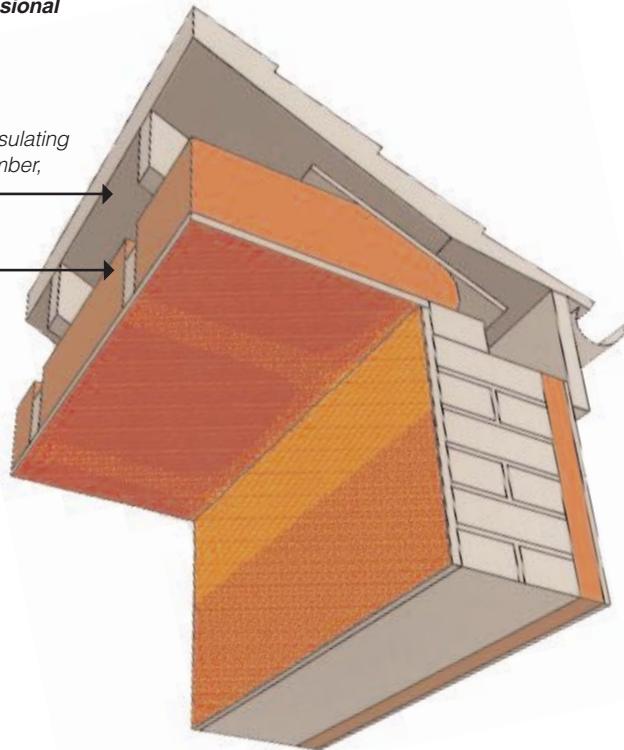
The surface temperatures in the Guide have been calculated using the TRISCO computer program based on finite element analysis. The calculations use an inside temperature of 18°C, typical of a reasonably well heated living room, and an outside temperature of 0°C, typical of cold winter conditions in the UK. The calculations were carried out assuming constant internal and external temperatures. This may give a slightly optimistic assessment of the performance of some constructions especially those with massive concrete or masonry elements, under the fluctuating temperatures found in intermittently heated housing.

The bridging effects of mortar joints and timber members have been taken into account when calculating the U-values.

## Key to three-dimensional illustrations

grey signifies non-insulating materials such as timber, brick or plaster

insulating material



## DISCLAIMER

The diagrams and details in this document are for illustrative purposes only. In many of the diagrams dpcs, dpms and vapour barriers have been omitted to reduce complexity.

Summary pages at the end of each chapter should not be regarded as 'working drawings' but simply recommendations on how to reduce thermal bridges.

# Solid brick walls

There are about seven million dwellings in England and Wales with solid brick external walls. They were mainly built in the Victorian period, but solid wall construction was common up to the 1930s.

The details investigated in this chapter are typical of the millions of houses built in the Victorian period. Walls are usually 225 mm thick, although 335 mm brickwork is commonly used for ground floors of three storey houses and around bay windows.

Lintels are usually of timber internally, with brick arches or stone lintels externally. Stone is the most common material for the sill. In 225 mm thick walls the stone sill can be the full thickness of the wall.

The main ground floor areas are usually of timber construction. Kitchens and ancillary rooms in back extensions often have solid ground floors. Both timber and solid concrete floors may well have been renewed or replaced by more modern construction.

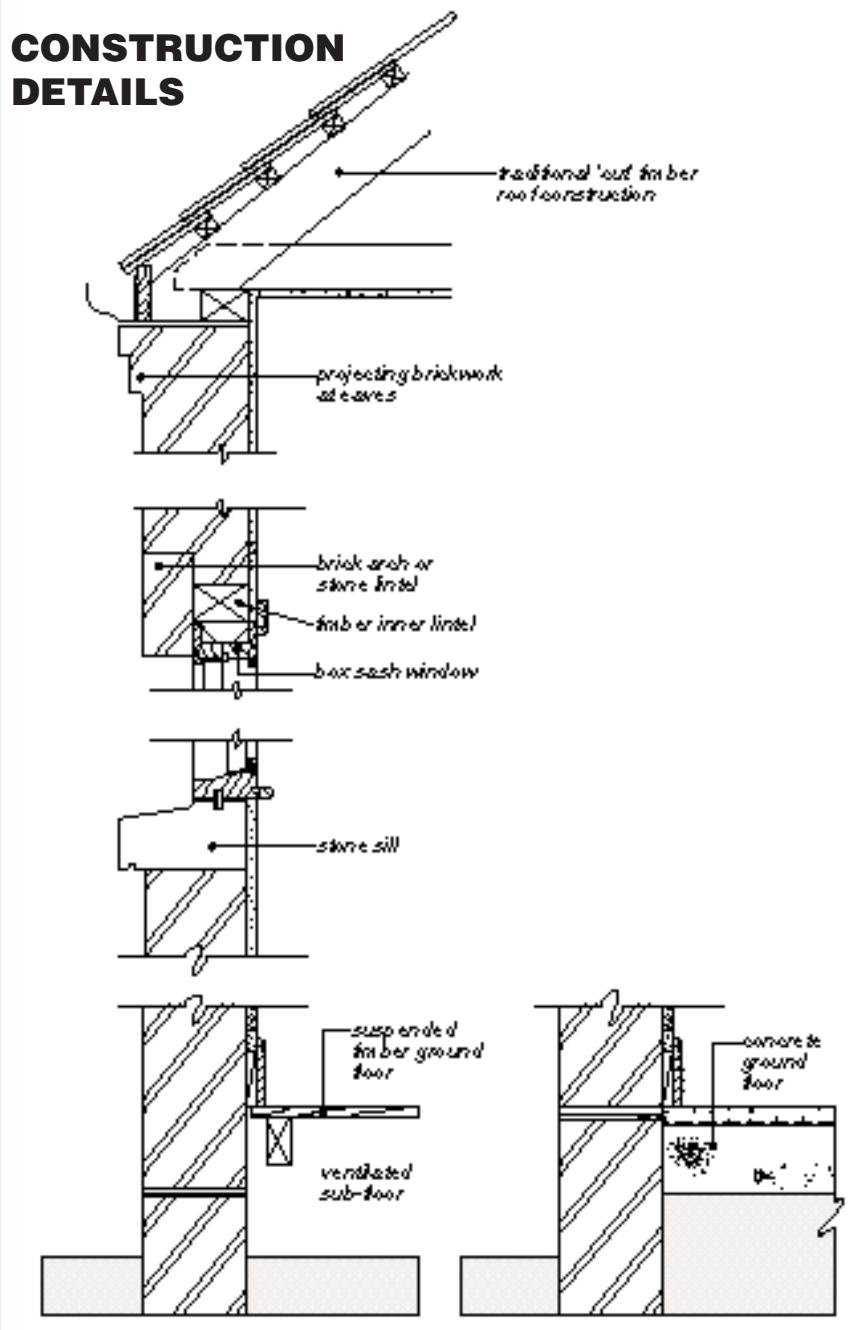
The original roof coverings are likely to have been replaced in the building's lifetime. No insulation would have been included in pitched roofs when they were built originally. However, there may now be anything from 25 to 150 mm of loft insulation as a result of the various government insulation schemes over the last 20 years.

The following two pages show the thermal analysis of the crucial junctions in the construction. The lack of any insulation means that the roof, external walls and ground floors all have high heat losses. The areas at greatest risk from condensation and mould growth are:

- ceilings below uninsulated roofs
- external corners of walls
- just above the skirting level at ground floor level
- below the window sill
- at the perimeter of ground floors.

The remaining pages in this chapter show the effect of adding insulation internally and externally.

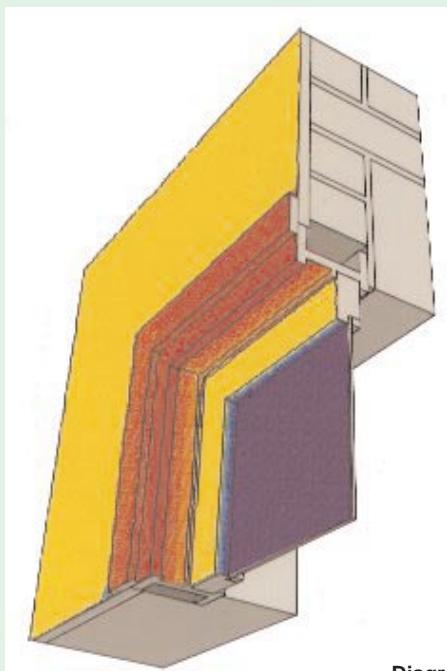
## CONSTRUCTION DETAILS



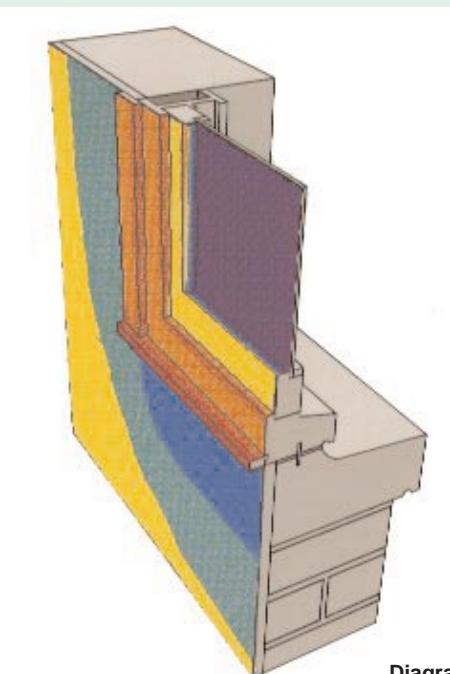
# Uninsulated construction

**A****EAVES JUNCTION**

With no insulation in the roof, the whole of the ceiling forms a thermal bridge. There is a high risk of mould growth occurring at the top of the walls and on the ceiling.

**Diagram B1.2****Diagram A1.1****LINTEL JUNCTION****B**

With no obvious thermal breaks at the lintel or jamb, the surface temperature of the wall is very even.

**Diagram C1.3****C****SILL JUNCTION**

The high risk of mould growth and condensation below the sill is because of the thermal bridge through the stone sill. The temperature at the jamb is lower than in the lintel detail because the lower sash of the vertical sliding window is closer to the inside surface of the wall.

**D****CONCRETE GROUND FLOOR JUNCTION**

This diagram shows clearly the high risk of mould growth at the corner of the room and at skirting level.

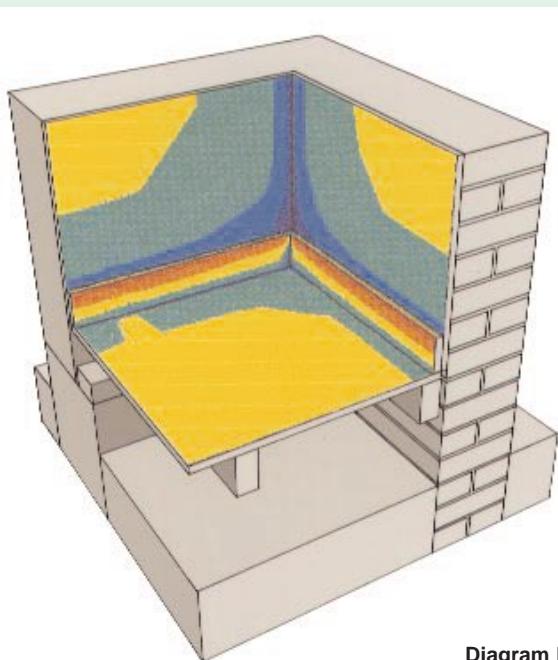


Diagram D1.5

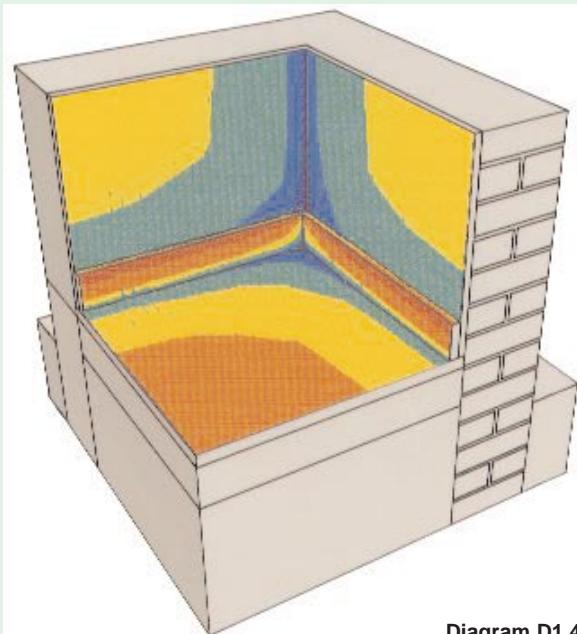


Diagram D1.4

**TIMBER GROUND FLOOR JUNCTION****E**

The surface temperatures at the corner of the room are similar to those shown in Diagram D1.4 for the uninsulated concrete ground floor. The risk of mould growth is greatest at skirting level. This is because, in addition to the heat loss through the solid brick wall to the outside, the base of the wall also loses heat to the subfloor void and to the ground.

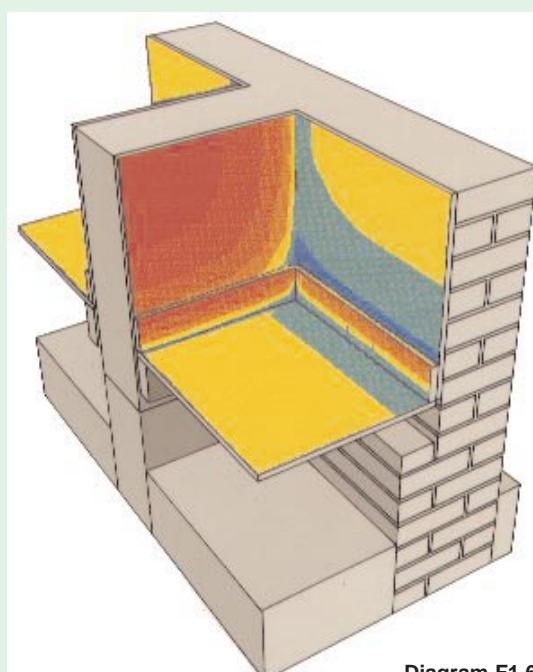


Diagram E1.6

**F****SEPARATING WALL JUNCTION**

The thermal bridge at the separating wall is less serious than at the external corner, but still presents a risk of mould growth at skirting level.

# Internal insulation added

Internal insulation is the most common way of insulating solid brick walls. It is usually less expensive than external insulation.

The examples of internal insulation in this chapter assume that the existing plaster finish has been removed and a 50 mm thick insulation/plasterboard laminate added. The insulant has a conductivity of 0.027 W/mK. Adding the dry-lining improves the U-value from 2.1 W/m<sup>2</sup>K to about 0.5 W/m<sup>2</sup>K. Internal insulation should include a vapour check on the warm side of the insulation.

### A EAVES JUNCTION – INTERNALLY INSULATED

#### MINOR THERMAL BRIDGE

The combination of 150 mm loft insulation and an insulated dry-lining avoids a thermal bridge at the eaves. The higher rate of heat loss through the joists is clearly visible.

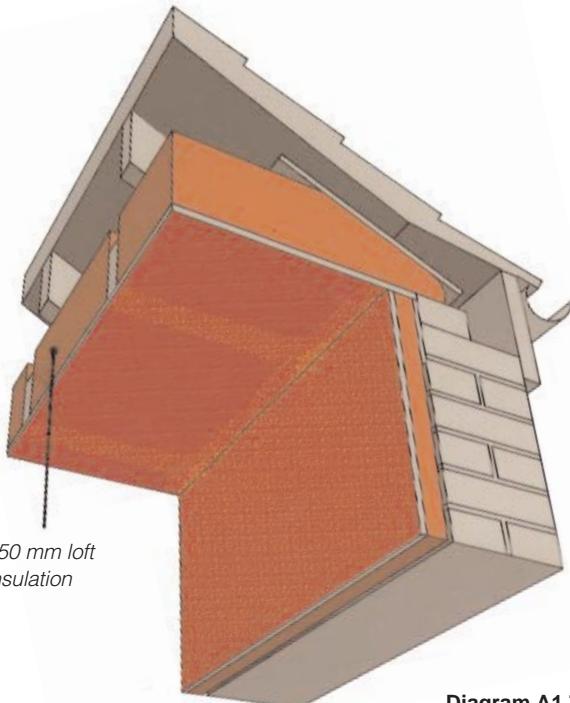


Diagram A1.7

#### BEST PRACTICE

The bridging effect of the joists is avoided by laying the loft insulation in two layers, one between the joists and one over the joists.

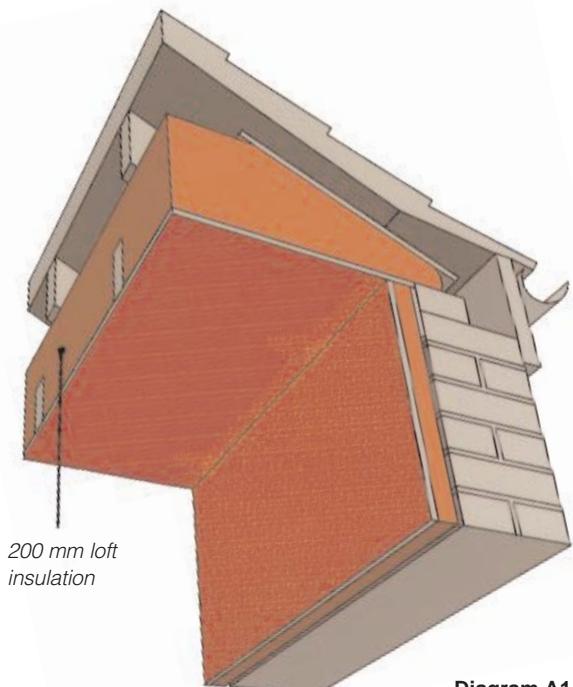


Diagram A1.8

## B LINTEL JUNCTION – INTERNALLY INSULATED

### BEST PRACTICE

Replacing the existing plaster finish with an insulated dry-lining produces a dramatic improvement in surface temperatures.

Where windows are placed towards the outside of the wall, the insulated dry-lining should be returned into the soffit and reveals to avoid a thermal bridge, as in Diagrams B2.23 and C2.24.

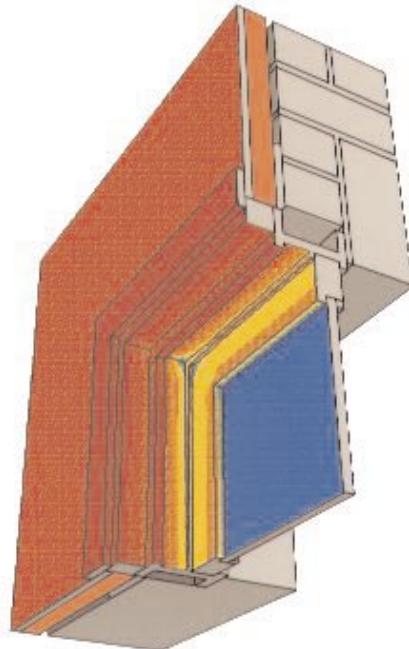


Diagram B1.9

## C SILL JUNCTION – INTERNALLY INSULATED

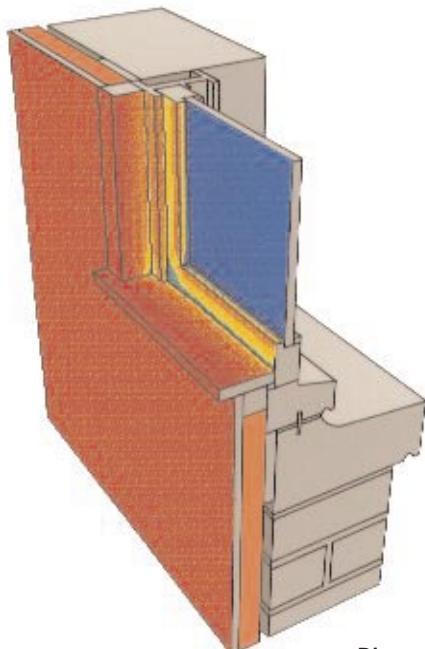


Diagram C1.10

### BEST PRACTICE

As for the lintel junction, the insulated dry-lining raises surface temperatures dramatically. There are no thermal bridges through the wall.

### D CONCRETE GROUND FLOOR JUNCTION – INTERNALLY INSULATED

#### MAJOR RISK OF MOULD

The insulated dry-lining completely eliminates the thermal bridge at the wall corner and above the skirting. There is a risk of mould at the floor with no floor insulation.

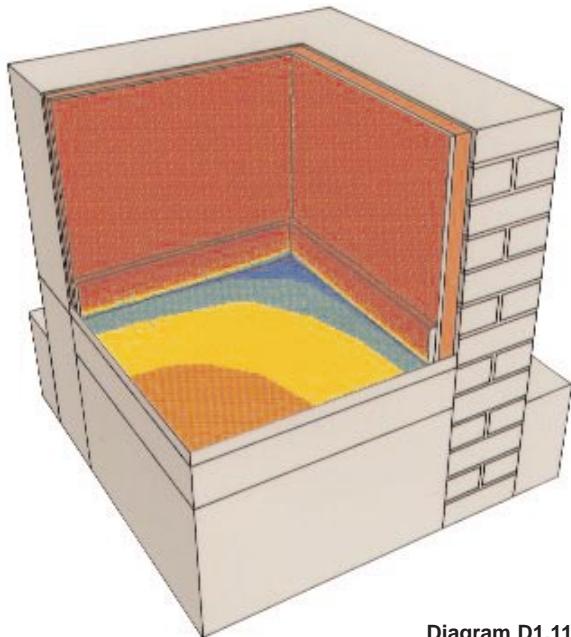


Diagram D1.11

#### BEST PRACTICE

By adding 25 mm of extruded polystyrene finished with 18 mm chipboard to the existing floor, the surface temperature of the floor is raised to that of the wall. However, raising the floor level in this way makes it necessary to shorten internal doors and presents problems at the junction with the staircase.

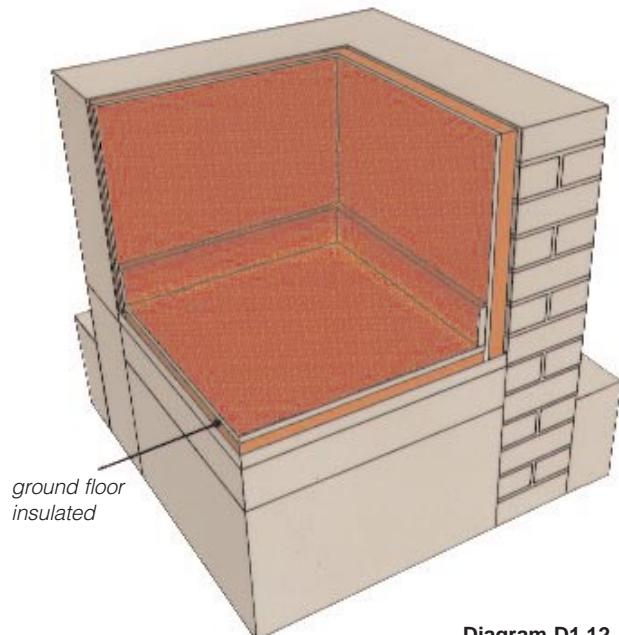


Diagram D1.12

## E TIMBER GROUND FLOOR JUNCTION – INTERNALLY INSULATED

### RISK OF MOULD

The insulated dry-lining completely eliminates the thermal bridge at the wall corner and above the skirting. However, the low surface temperatures of the uninsulated floor are largely unaffected by the addition of wall insulation.

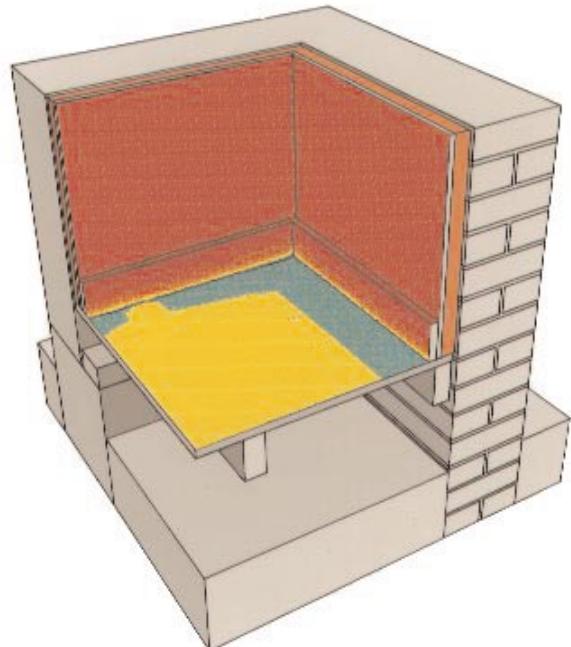


Diagram E1.13

### BEST PRACTICE

This diagram shows the effect of adding 100 mm mineral wool insulation between the floor joists – a warm internal envelope, with no serious thermal bridging.

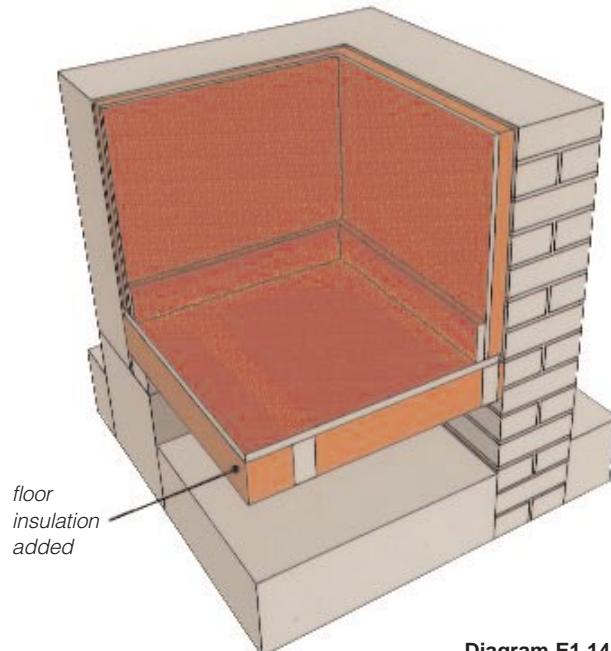


Diagram E1.14

### F SEPARATING WALL JUNCTION – INTERNALLY INSULATED

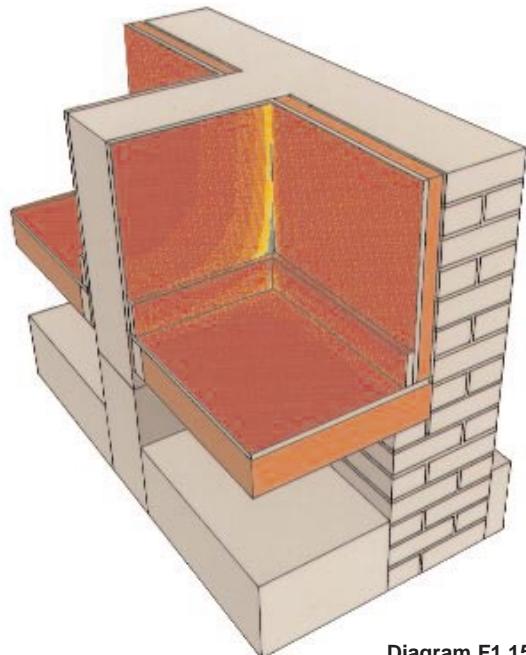


Diagram F1.15

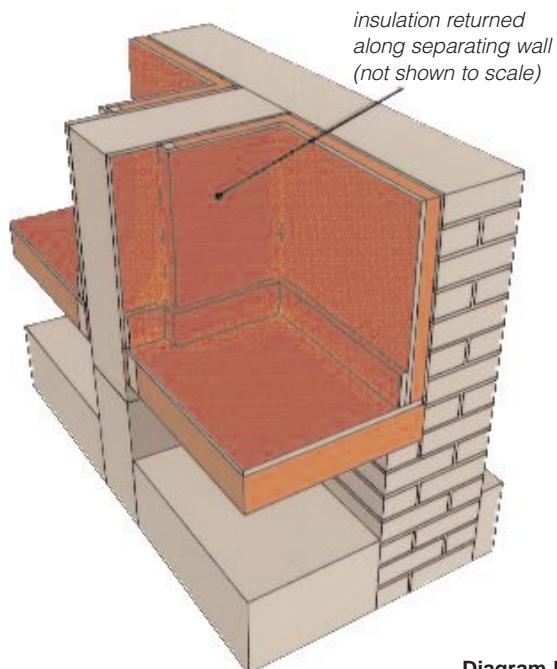


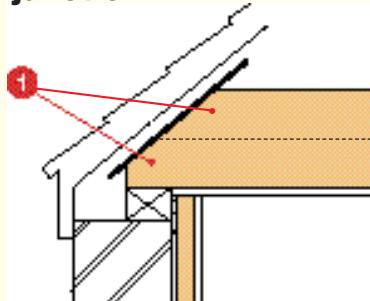
Diagram F1.16

#### BEST PRACTICE

Returning the insulated dry-lining by 1000 mm each side of the separating wall raises surface temperatures high enough to reduce the risk of mould growth.

## SUMMARY OF RECOMMENDATIONS – INTERNALLY INSULATED WALLS

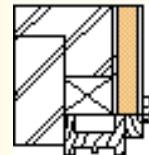
### A Eaves junction



#### Best practice

- 1 Lay the loft insulation in two layers, the first layer taken onto the wall plate, the second layer laid over the joists.

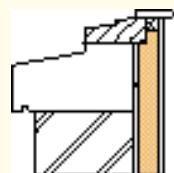
### B Lintel junction



#### Best practice

The insulation is continuous behind the wall and lintel. Return the insulation into reveals and soffits where applicable.

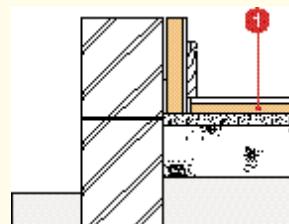
### C Sill junction



#### Best practice

The insulation is continuous behind the wall, sill and window frame.

### D Concrete ground floor junction

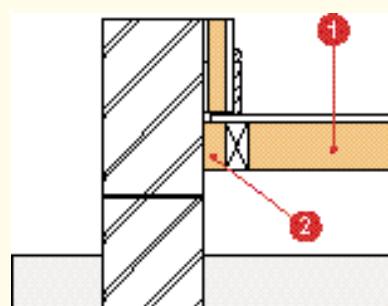


#### Best practice

- 1 Butt the floor insulation up against the dry-lining to avoid thermal bridging.

**Note:** This detail may be impractical if height adjustments to doors and staircases cannot be made.

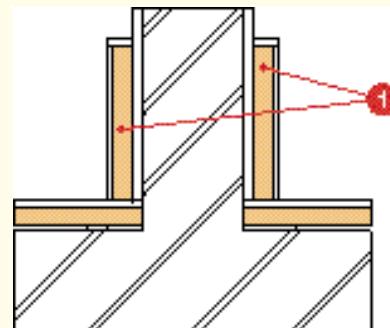
### E Timber ground floor junction



#### Best practice

- 1 Specify floor insulation as well as dry-lining to minimise thermal bridging, AND
- 2 Insulate between the last joist and the wall.

### F Separating wall junction



#### Best practice

- 1 Return the dry-lining at least 1000 mm both sides of the separating wall (not shown to scale).

**Note:** Consideration should be given to the aesthetics of this detail. It may be preferable to cover the whole of the internal wall or stop the insulation at an acceptable point depending on room layout.

**Note:** Internal insulation should include a vapour check on the warm side of the insulation.

# External insulation added

The externally insulated walls in this chapter assume a 50 mm thick insulant with a conductivity of 0.036 W/mK. The insulation is protected with a thin polymer render. Adding the external insulation improves the U-value to about 0.53 W/m<sup>2</sup>K.

External insulation is unsuitable for use on listed buildings or where the external walls have fine architectural detailing or moulding.

The design and installation of external insulation is a specialist job. It is strongly recommended to use an insulation system with an Agrément Certificate and a specialist installer approved by the certificate holder.

### A EAVES JUNCTION – EXTERNALLY INSULATED

#### THERMAL BRIDGE

Where there is a gap between the loft and wall insulation, there is a thermal bridge at eaves level. The bridging effect of the joists is avoided by laying a second layer of insulation over the joists as in diagram A1.18.



Diagram A1.18



Diagram A1.17

#### BEST PRACTICE

Where the roof covering is being replaced, there is an opportunity to place loft insulation over the wall plate. This eliminates the thermal bridge. With this detail care is needed to maintain a minimum 50 mm ventilation path above the insulation.

## B LINTEL JUNCTION – EXTERNALLY INSULATED

### THERMAL BRIDGE

If the external wall insulation is stopped as shown in the diagram, there is a thermal bridge through the external soffit and jambs.

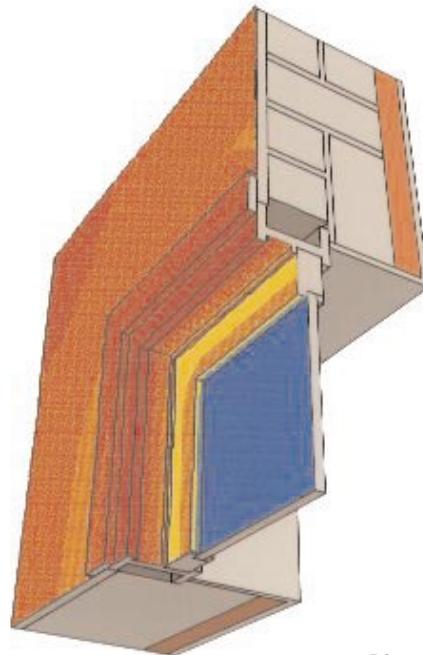


Diagram B1.19

### BEST PRACTICE

Adding 13 mm of insulation to the soffit and jambs avoids a thermal bridge. The visible width of the window frame should be sufficient to accept the combined thickness of the external insulation and protective render.

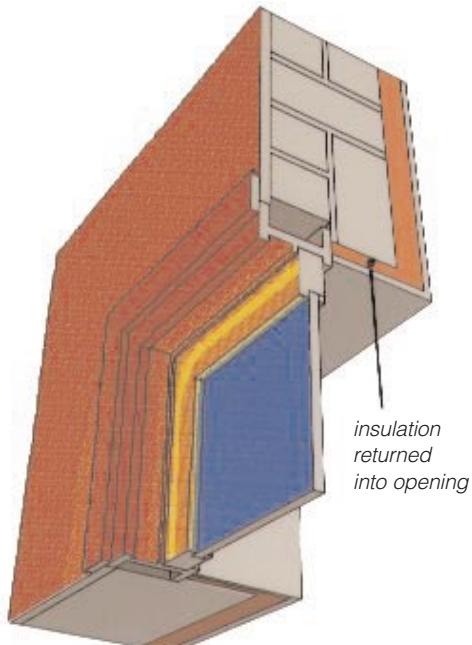


Diagram B1.20

### C SILL JUNCTION – EXTERNALLY INSULATED

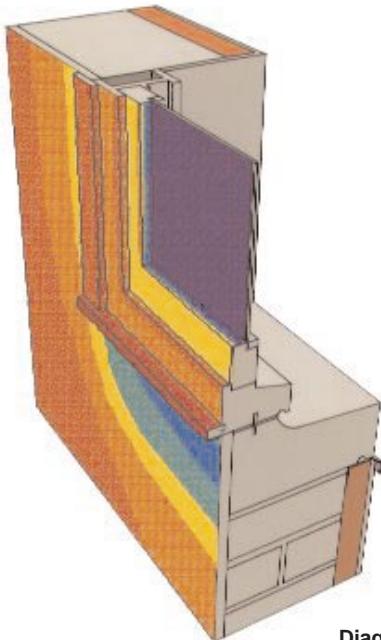


Diagram C1.21

#### MAJOR RISK OF MOULD

If the external wall insulation is stopped at the sill and not taken into the jamb reveal, there is a thermal bridge at the jamb and a serious thermal bridge at the sill.

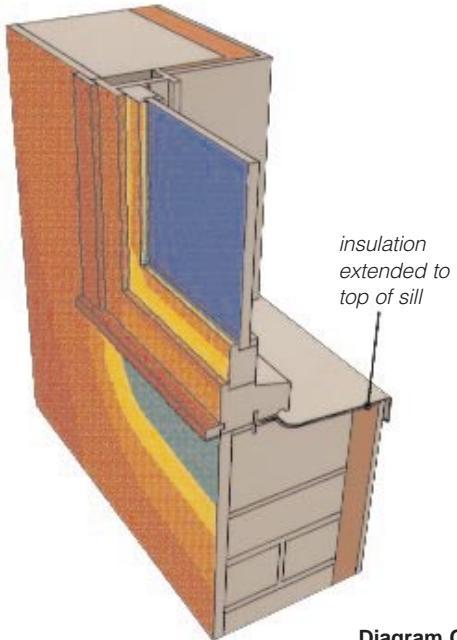


Diagram C1.22

#### RISK OF MOULD

Returning the external insulation into the reveal avoids the thermal bridge at the jamb. However, extending the external insulation over the front face of the stone sill still leaves a thermal bridge serious enough for there to be a risk of mould growth.

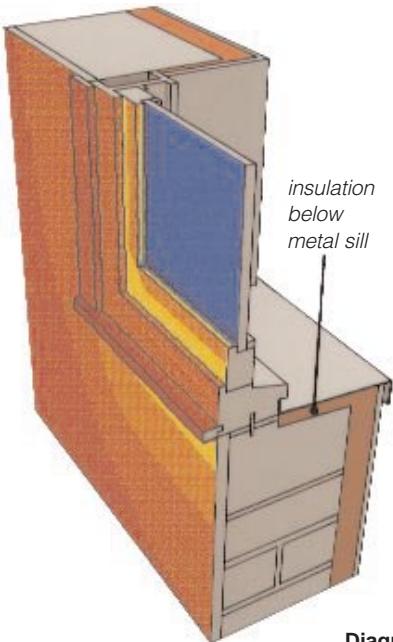


Diagram C1.23

#### Thermal Bridge

Extending the external insulation over the top of the sill to link up with the window frame reduces the thermal bridge to the point where there is little risk of mould growth. However, this involves cutting back the existing stone sill and has implications for the external appearance of the property.

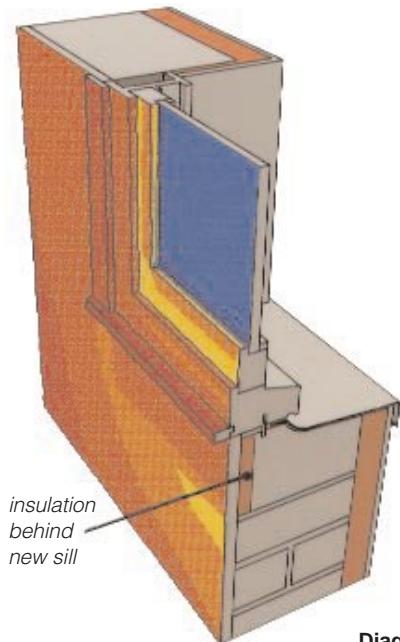


Diagram C1.24

#### Thermal Bridge

Where the existing sill is being replaced, adding insulation on the inside of the new sill helps to reduce the thermal bridge and minimise the risk of mould growth.

## D CONCRETE GROUND FLOOR JUNCTION – EXTERNALLY INSULATED

### RISK OF MOULD

The addition of external wall insulation results in much warmer wall surfaces and a less severe thermal bridge at the wall and floor perimeter. However, there is still a risk of mould growth at the corner – on the wall and on the floor.

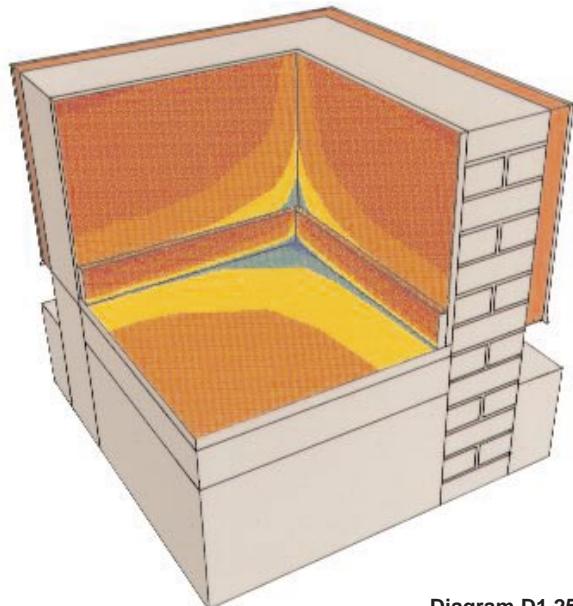


Diagram D1.25

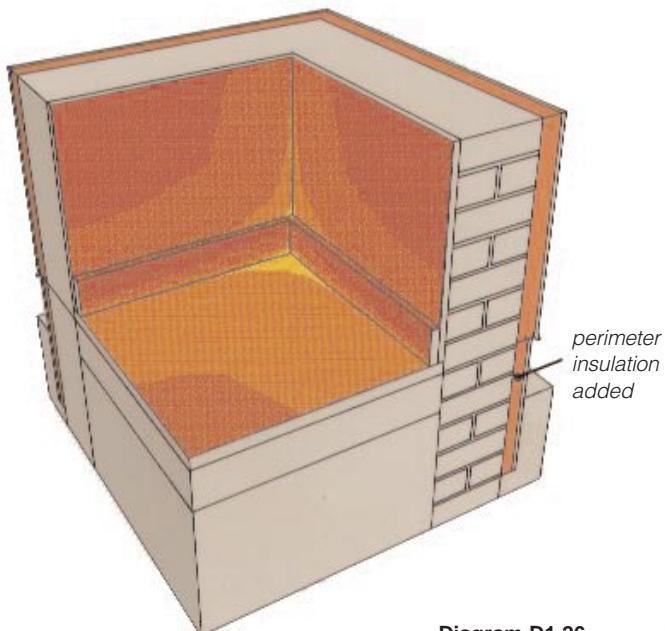


Diagram D1.26

### THERMAL BRIDGE

The effect of extending the wall insulation below dpc level is much more beneficial with concrete floors than with timber suspended floors. The severity of the thermal bridging is reduced to a point where there is little risk of mould growth occurring.

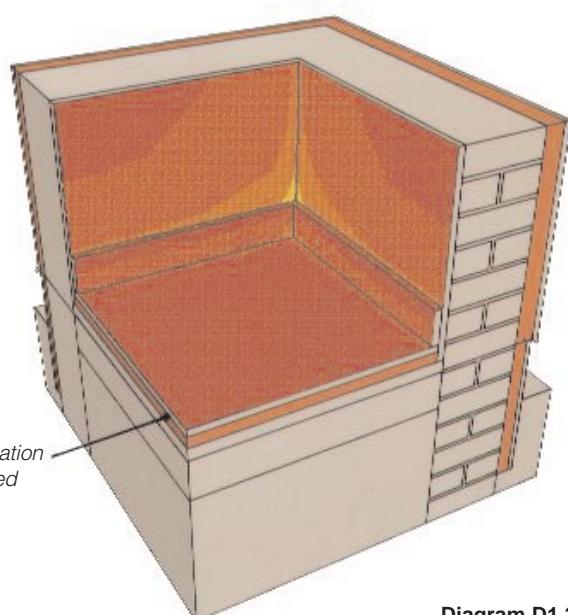


Diagram D1.27

### BEST PRACTICE

Adding 25 mm of extruded polystyrene insulation and 18 mm chipboard results in a much warmer floor surface than with perimeter insulation alone. However, unless the properties are being decanted this will not be a practical option; internal doors need to be shortened and there are problems at the junction with the staircase.

### E TIMBER GROUND FLOOR JUNCTION – EXTERNALLY INSULATED

#### RISK OF MOULD

The addition of external insulation results in much warmer wall surfaces and a less severe thermal bridge in the corner of the room and at skirting level. However, there is still a small risk of mould growth on the wall and at the edge of the floor.

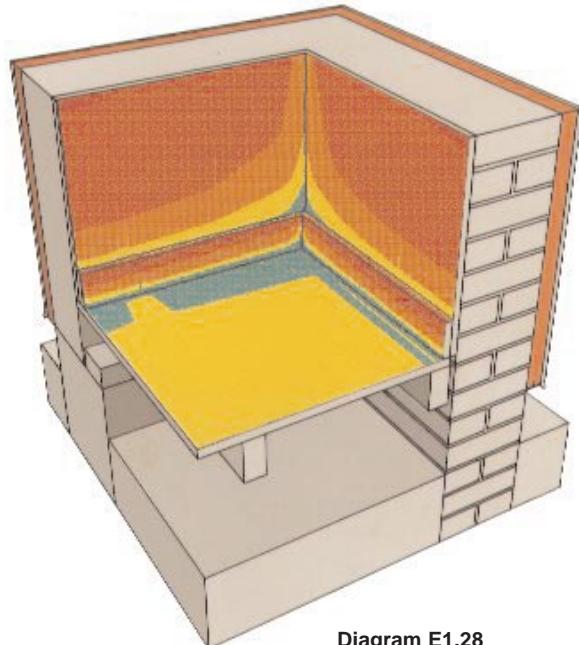


Diagram E1.28

#### SLIGHT RISK OF MOULD

The addition of 100 mm mineral wool between the joists not only increases the floor surface temperatures substantially but also has the effect of reducing the thermal bridge through the wall. This is mainly due to the longer thermal bridge path from the skirting to the floor void.

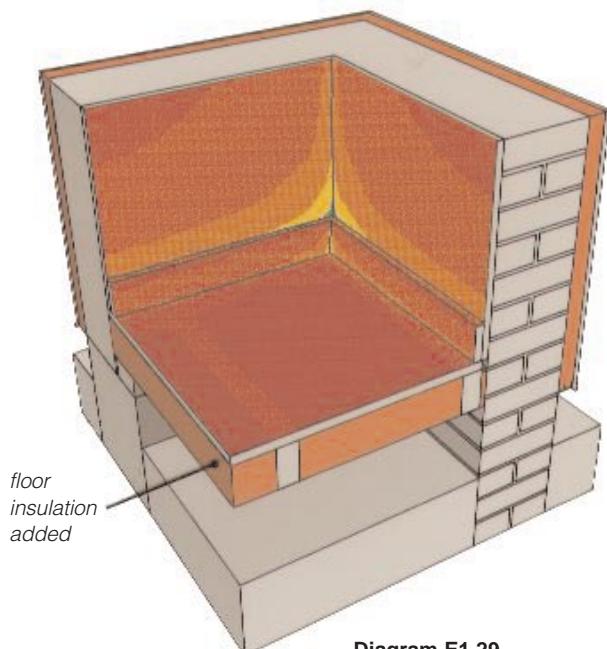


Diagram E1.29

#### MINOR THERMAL BRIDGE

Extending the external wall insulation below dpc level makes only a marginal difference to the thermal bridge at skirting level. This is because the main heat flow path is to the cold sub-floor void.

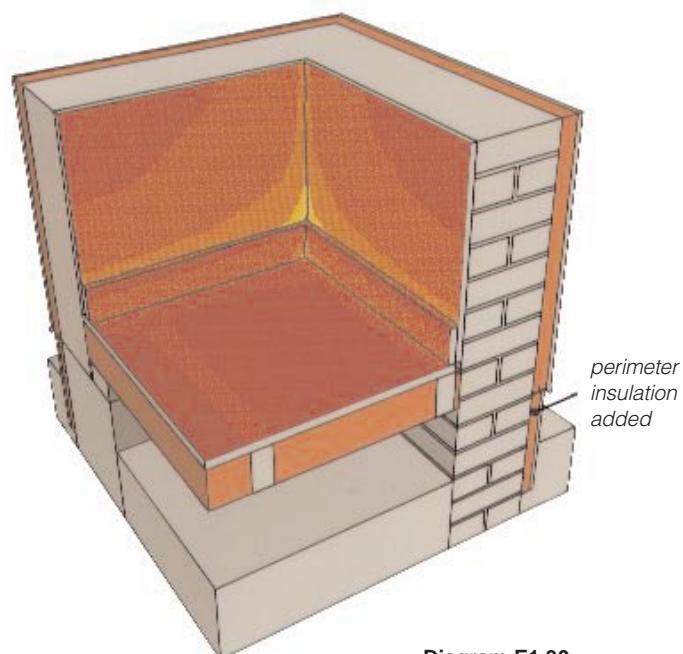


Diagram E1.30

## F SEPARATING WALL JUNCTION – EXTERNALLY INSULATED

### THERMAL BRIDGE

Adding external insulation virtually eliminates the risk of mould growth at the junction of the external and separating wall. The coldest surface temperatures are at the floor perimeter.

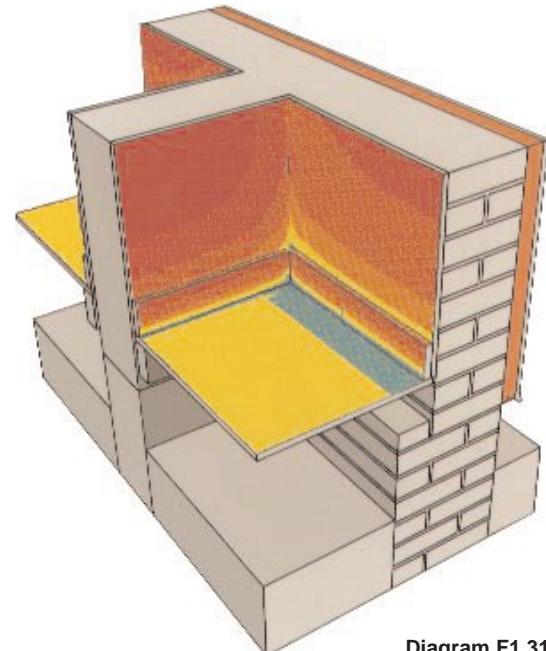


Diagram F1.31

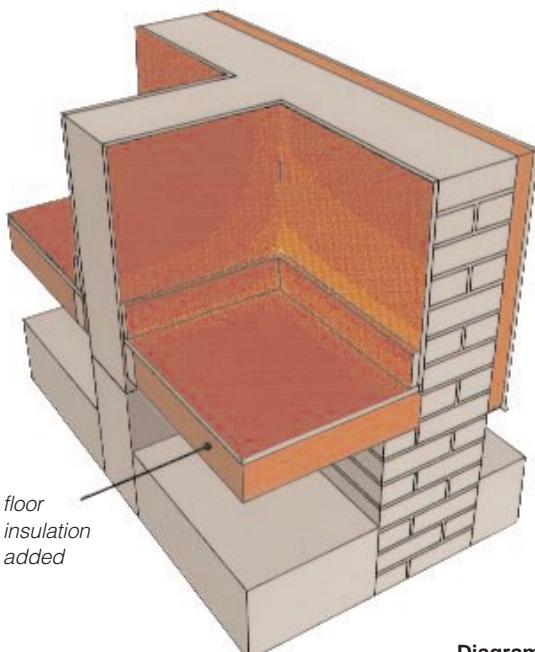


Diagram F1.32

### MINOR THERMAL BRIDGE

As with the external corner, shown in Diagram 1.29, the addition of floor insulation helps to reduce the severity of the thermal bridge above skirting level.

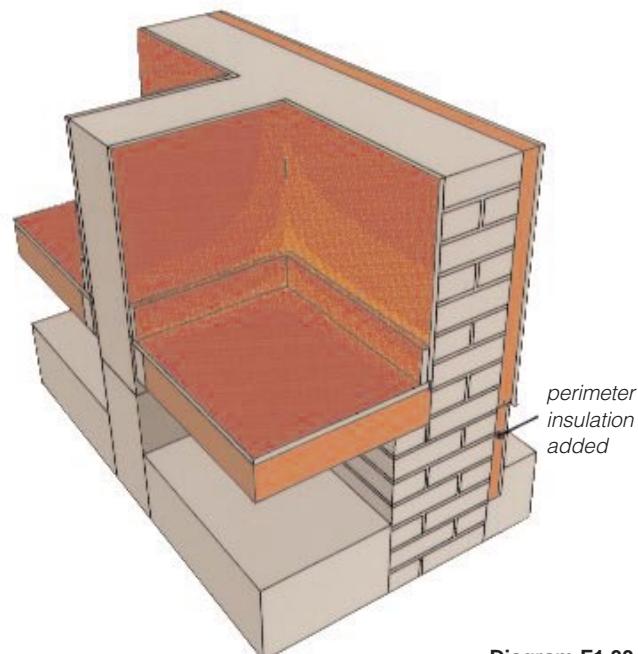


Diagram F1.33

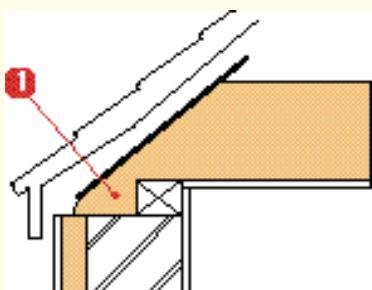
### BEST PRACTICE

Extending the external wall insulation below dpc level provides the best solution.

## Solid brick walls

### SUMMARY OF RECOMMENDATIONS – EXTERNALLY INSULATED WALLS

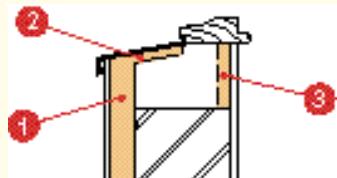
#### A Eaves junction



##### Best practice

- 1 Take the loft insulation over the wall plate and link up with the external wall insulation.

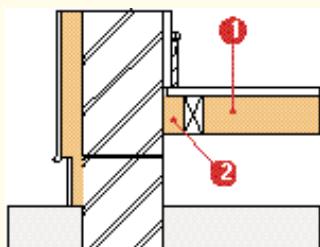
#### C Sill junction



##### Minimum recommendations

- 1 Take wall insulation over the face of the sill, and either
- 2 Extend the insulation over the sill, OR
- 3 Add insulation to the back of the sill.

#### E Timber ground floor junction

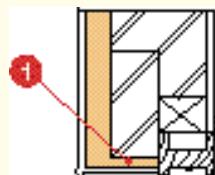


##### Minimum recommendations

- 1 Specify floor insulation as well as external insulation to minimise thermal bridging, AND
- 2 Insulate between the last joist and the wall.

**Note:** Minimum recommendations provide advice on reducing the risk of mould growth.

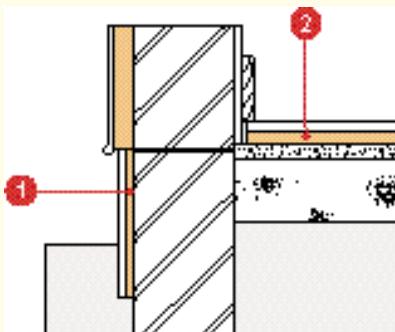
#### B Lintel junction



##### Best practice

- 1 Return the wall insulation into the openings to butt up against the window frame.

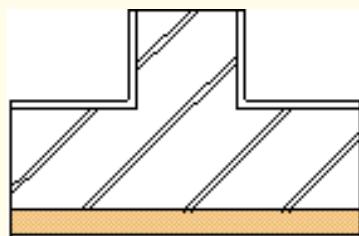
#### D Concrete ground floor junction



##### Best practice

- 1 Add perimeter insulation below dpc level, AND
- 2 Insulate the concrete floor.

#### F Separating wall junction



##### Best practice

The external insulation is continuous and avoids thermal bridging through the separating wall.

# Traditional cavity wall construction

Although experimentation with cavity wall construction began in Victorian times, it was not until the 1930s that it was widely used.

The details shown are typical of cavity wall construction in the 1950s, when it became the dominant form of construction for dwellings. Details and materials used vary widely throughout the country and often display a strong regional influence.

Brick was commonly used to construct both inner and outer leaves. Where blocks were used for the inner leaf, they usually had a thermal conductivity value similar to brick, giving a U-value of about  $1.5 \text{ W/m}^2\text{K}$  for the wall. It was only with the introduction of lightweight aggregate blocks and later aerated concrete blocks that U-values as low as  $1.0 \text{ W/m}^2\text{K}$  were possible with a clear cavity. It was usual to close the top of a cavity with bricks which created a thermal bridge at the eaves.

Many of the commonly used types of lintel, such as the concrete boot lintel and the folded steel lintel shown on the right, also form thermal bridges through the wall.

Most roofs were of pitched construction. They were normally uninsulated up to the 1960s when 20 or 25 mm of insulation was usually provided. However, as a result of government insulation grants in recent years, many roofs now have up to 150 mm of loft insulation.

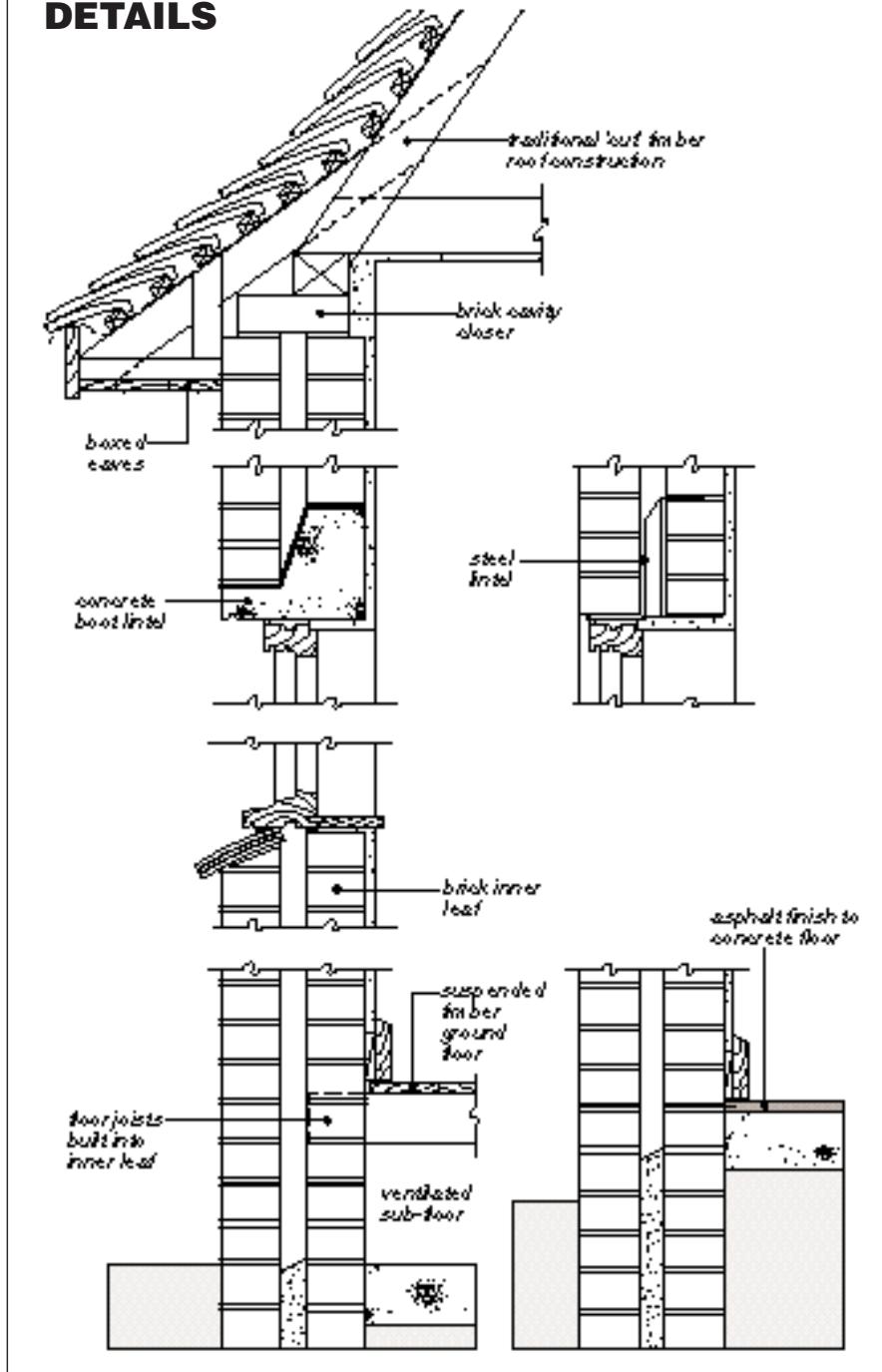
Both suspended timber and ground supported concrete slabs were widely used for ground floors. Suspended timber floors were usually built off sleeper walls with a shallow sub-floor void for ventilation. The solid floor detail shows an asphalt finish. This performed the dual role of damp proof membrane and levelling screed.

The following three pages show the thermal analyses of the crucial junctions in the construction. The areas at greatest risk from condensation and mould growth are:

- brick closers at eaves levels
- ceilings below uninsulated roofs
- soffits below concrete boot and steel lintels
- external corners of walls
- the perimeter of ground floors.

The remaining pages in this chapter show the effect of adding cavity insulation and an insulated dry-lining. External insulation is not shown in this chapter. If external insulation is being considered, follow the advice given in Chapter 1.

## CONSTRUCTION DETAILS



## Uninsulated construction

**A**

### EAVES JUNCTION

Even with 25 mm of loft insulation, the heat loss is half that through an uninsulated roof. The lowest surface temperatures are due to the thermal bridge through the brick cavity closer.

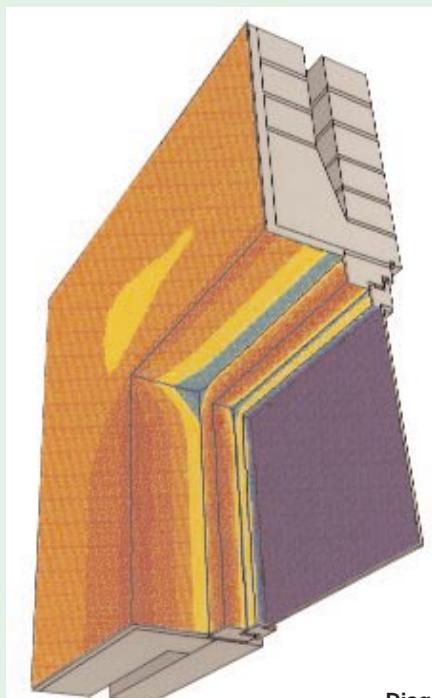


Diagram B2.2



Diagram A2.1

### BOOT LINTEL JUNCTION

**B**

The highest risk of mould growth occurs at the soffit rather than at the back of a boot lintel.

**C****STEEL LINTEL JUNCTION**

The risk of mould growth with a steel lintel is similar to that with a concrete boot lintel.

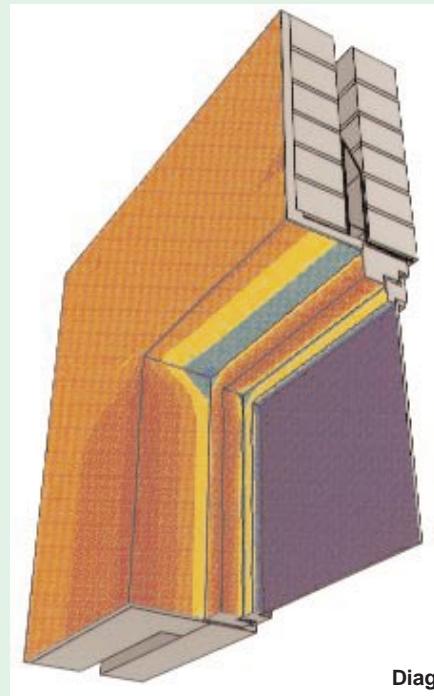


Diagram C2.3

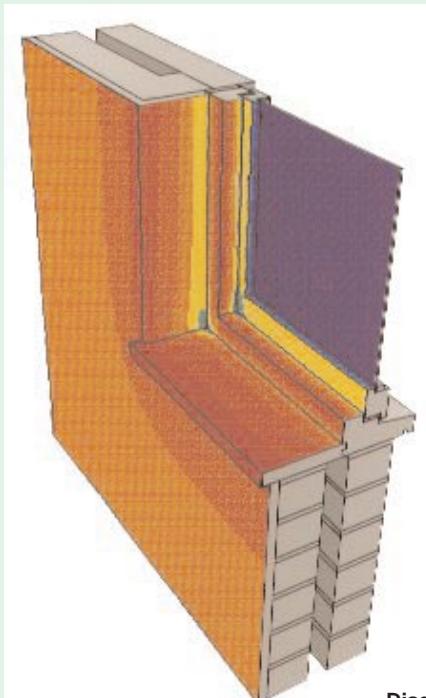


Diagram D2.4

**SILL JUNCTION****D**

The coldest wall surfaces occur in the corner at the junction of the reveal and the window board – a common spot for mould growth to start. The relatively good thermal properties of timber result in the window board being much warmer than the reveal.

## Traditional cavity wall construction

**E**

### CONCRETE GROUND FLOOR JUNCTION

The thermal analysis showed that surface temperatures at the wall/floor junction and in the external corner can fall below 13.5°C creating a high risk of mould growth.

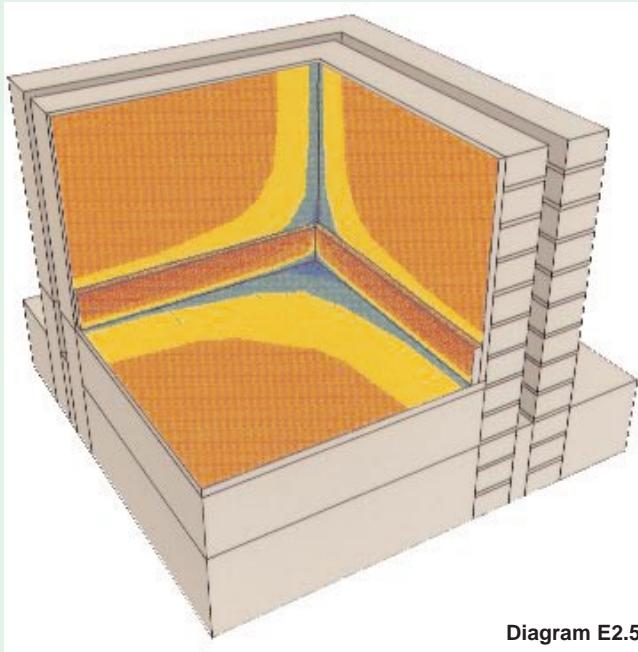


Diagram E2.5

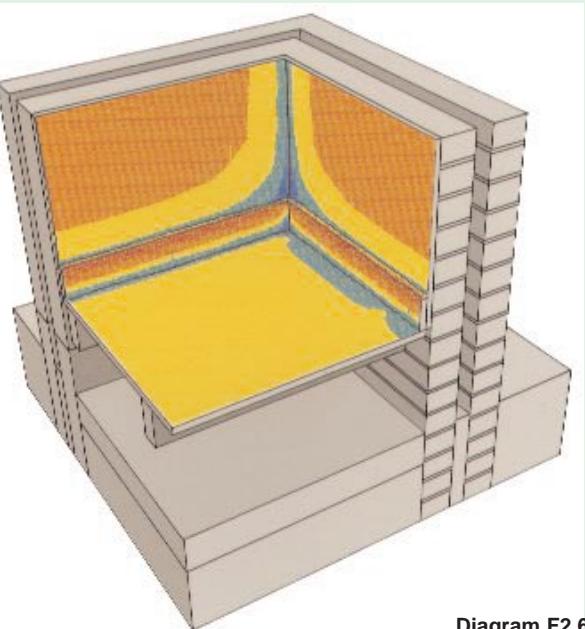


Diagram F2.6

**F**

### TIMBER GROUND FLOOR JUNCTION

The surface temperatures are similar to the uninsulated concrete ground floor. There is a risk of mould growth in the corner of the room and at the floor perimeter.

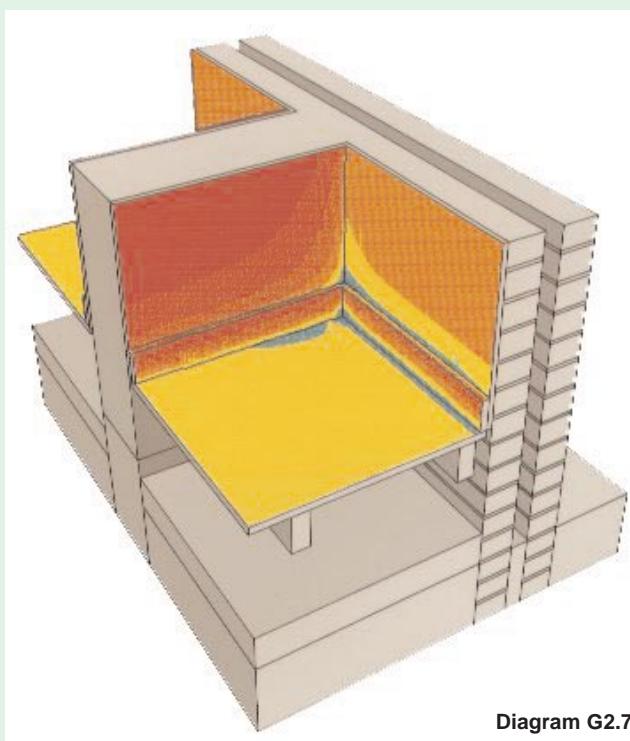


Diagram G2.7

**G**

### SEPARATING WALL JUNCTION

The lowest temperatures occur just above skirting level on the external wall. The high thermal mass of the separating wall keeps its surfaces at a relatively high temperature.

# Cavity insulation added

Blowing or pumping insulation into the cavity is the most common way of insulating cavity walls. It is much cheaper than internal or external insulation.

The examples in this chapter assume the existing cavity is 50 mm wide and filled with insulation with a thermal conductivity of 0.04 W/mK. This improves the U-value of a brick/cavity/brick wall from 1.5 W/m<sup>2</sup>K to about 0.57 W/m<sup>2</sup>K. If the existing wall cavity is 60 mm wide, cavity insulation would improve the U-value to about 0.5 W/m<sup>2</sup>K.

The insulation material used for cavity wall insulation must have third party certification, such as an Agrément Certificate. Installation should be carried out under an approved surveillance scheme by an approved installer. The existing wall should be assessed using the procedures in BS 8208 'Guide to assessment of suitability of external cavity walls for filling with thermal insulants Part 1 Existing traditional cavity constructions'.

A

## EAVES JUNCTION – CAVITY INSULATED



### BEST PRACTICE

Where the roof covering is being replaced, there is an opportunity to place insulation over the wall plate. Taking the insulation down over the edge of the brick closer raises surface temperatures further, but care is needed to maintain a minimum 50 mm ventilation path above the insulation. The warmest surfaces are achieved where the loft insulation can be taken down to completely cover the brick cavity closer. Check that ventilation to the loft space does not become blocked by the insulation.



Diagram A2.8

### B BOOT LINTEL JUNCTION – CAVITY INSULATED

#### SLIGHT RISK OF MOULD

The addition of cavity insulation raises the surface temperature at the soffit because the insulation in front of the bulk of the lintel helps to keep it warm. However, the reveal and soffit are significantly colder than the main wall surface and there is a risk of mould growth occurring at the corner.

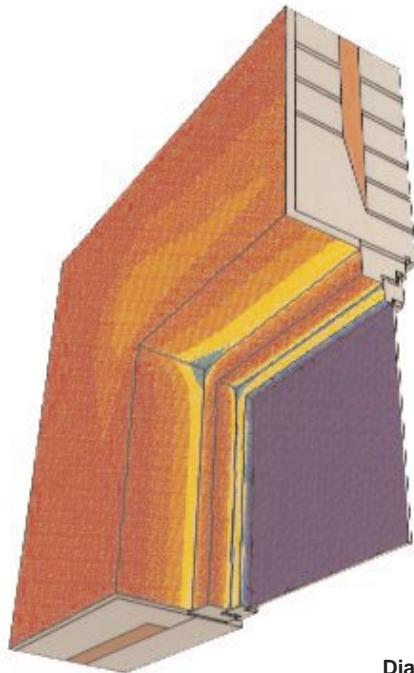


Diagram B2.10

#### THERMAL BRIDGE

Adding 13 mm of expanded polystyrene insulation to both the reveal and soffit raises their surface temperatures to the same level as the main wall area. However, it also has the effect of making the thermal bridge through the back of the boot lintel more pronounced.

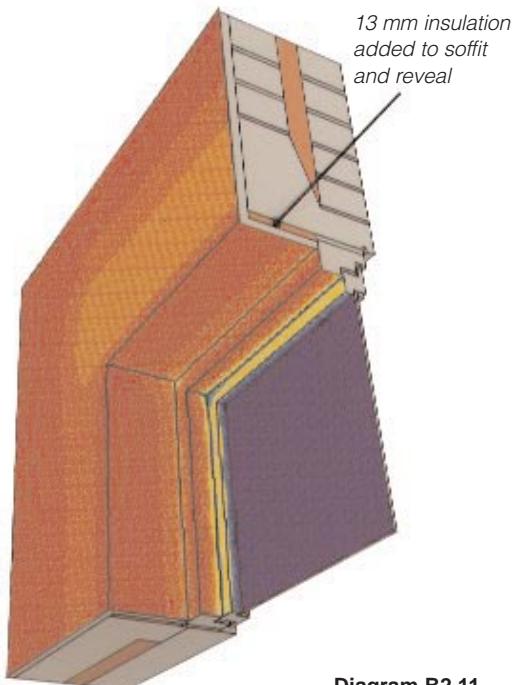


Diagram B2.11

#### MINOR THERMAL BRIDGE

The effect of adding 25 mm of expanded polystyrene to the back of the boot lintel is to eliminate the thermal bridge there, but also to lower slightly the surface temperature of the soffit and the back of the block closer at the jamb.

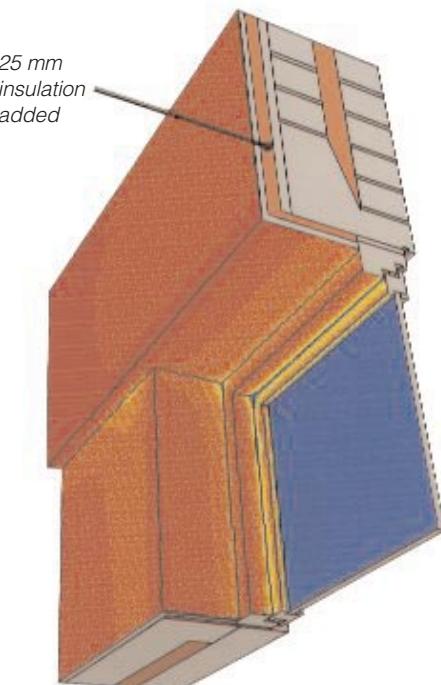


Diagram B2.12

## C STEEL LINTEL JUNCTION – CAVITY INSULATED

### RISK OF MOULD

The continuous steel member at the base of the lintel is responsible for the high risk of mould growth at the soffit.

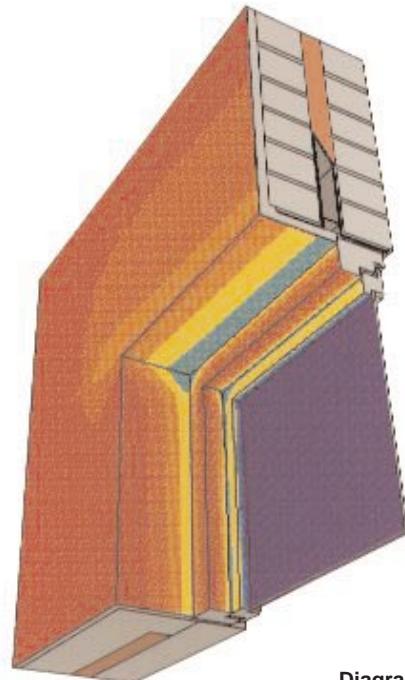


Diagram C2.13

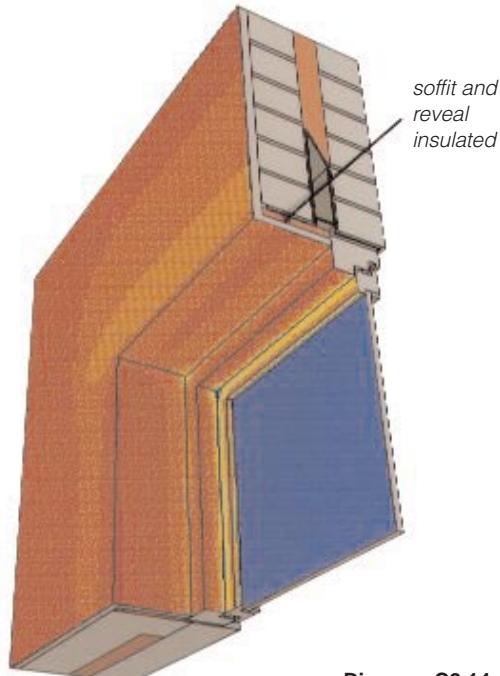


Diagram C2.14

### THERMAL BRIDGE

Adding 13 mm expanded polystyrene to the soffit and reveal is sufficient to raise temperatures above the level at which mould growth is a risk. However, the effect of the thermal bridge through the lower steel member can still be seen clearly.

### D SILL JUNCTION – CAVITY INSULATED

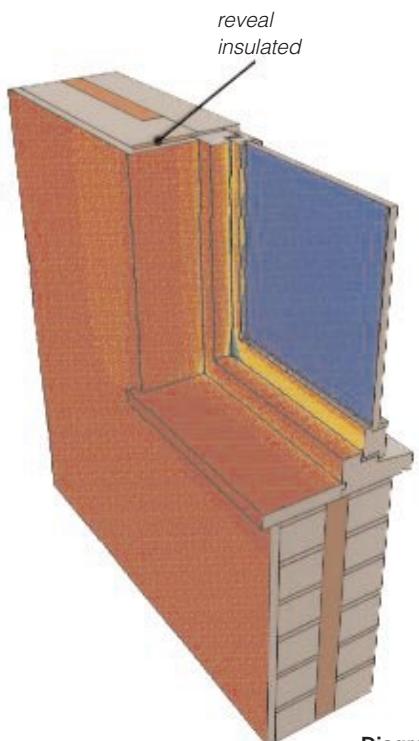


Diagram D2.16

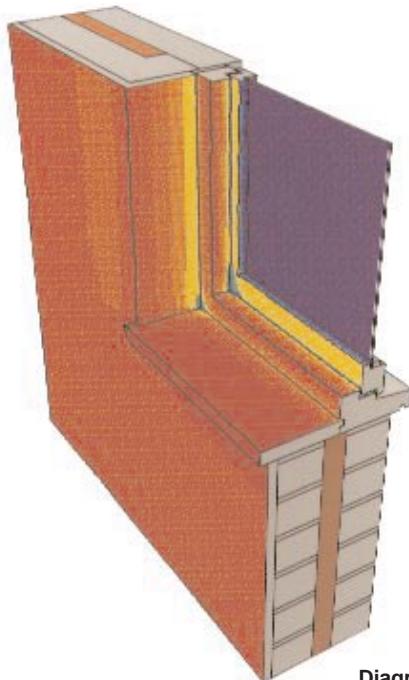


Diagram D2.15

#### BEST PRACTICE

To raise the temperature at the reveal, it is necessary to add insulation; in this case with 13 mm of expanded polystyrene finished with 12 mm plasterboard.

## E CONCRETE GROUND FLOOR JUNCTION – CAVITY INSULATED

### SLIGHT RISK OF MOULD

Filling the cavities with insulation eliminates the risk of mould growth at the corner of the wall. However, the thermal bridge at the perimeter of the concrete ground floor is severe enough to present a risk of mould growth at the corner.

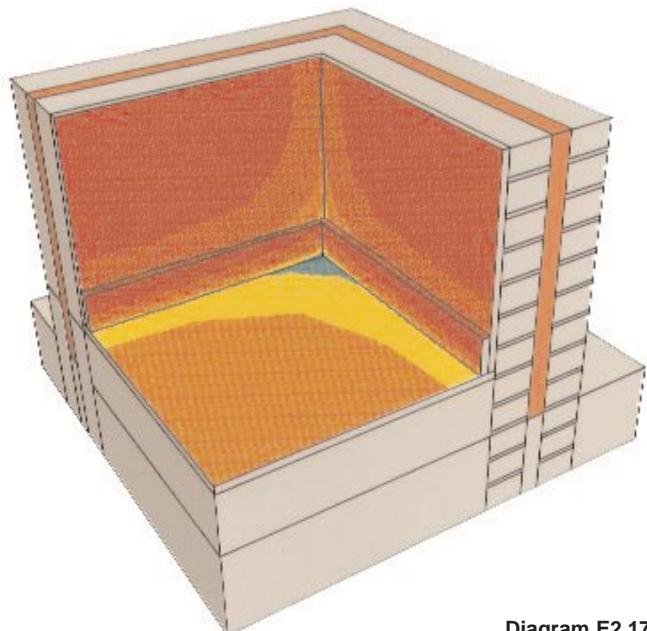


Diagram E2.17

### BEST PRACTICE

Laying 25 mm of insulation and 18 mm chipboard on the concrete floor has the effect of raising the surface temperature of the floor to that of the cavity filled wall. However, the addition of the insulation makes it necessary to shorten internal doors and presents problems at the junction with the staircase.

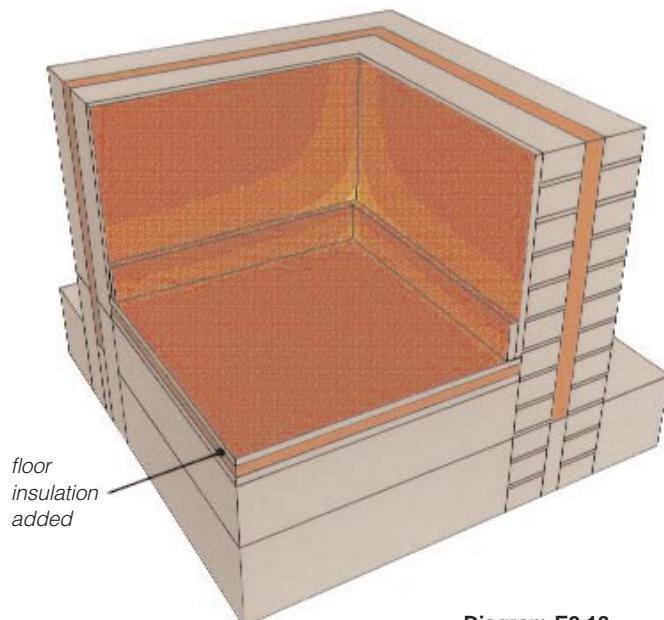


Diagram E2.18

### F TIMBER GROUND FLOOR JUNCTION – CAVITY INSULATED

#### RISK OF MOULD

Filling the wall cavity with insulation raises surface temperatures by about 2°C and almost eliminates the risk of mould growth in the corner. Although the wall surface temperatures fall towards the skirting, the lowest temperatures occur at the perimeter of the uninsulated timber floor.

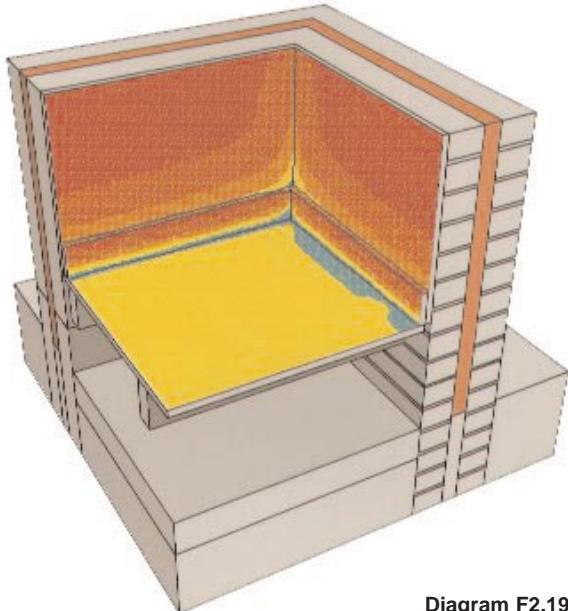


Diagram F2.19

#### BEST PRACTICE

The combination of cavity fill and insulation between the joists of the timber ground floor virtually eliminates thermal bridging. With this detail, it would be necessary to take up the existing floor boards in order to position the insulation between the joists. It is important to ensure that the gap between the last joist and the wall is filled with insulation.

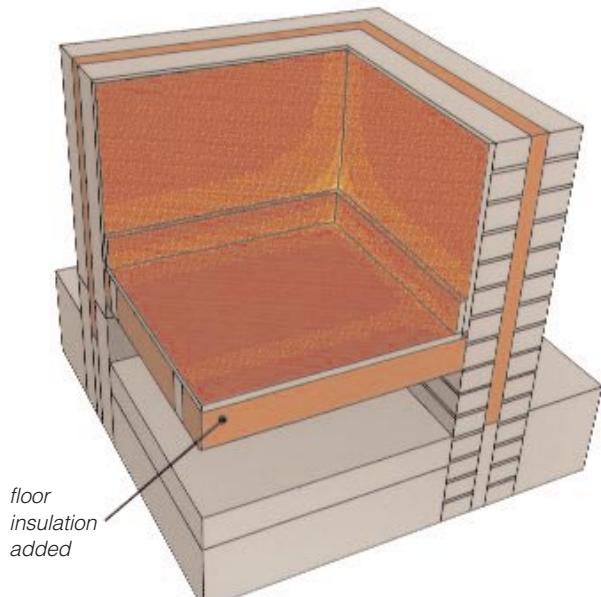


Diagram F2.20

**G**

## SEPARATING WALL JUNCTION – CAVITY INSULATED

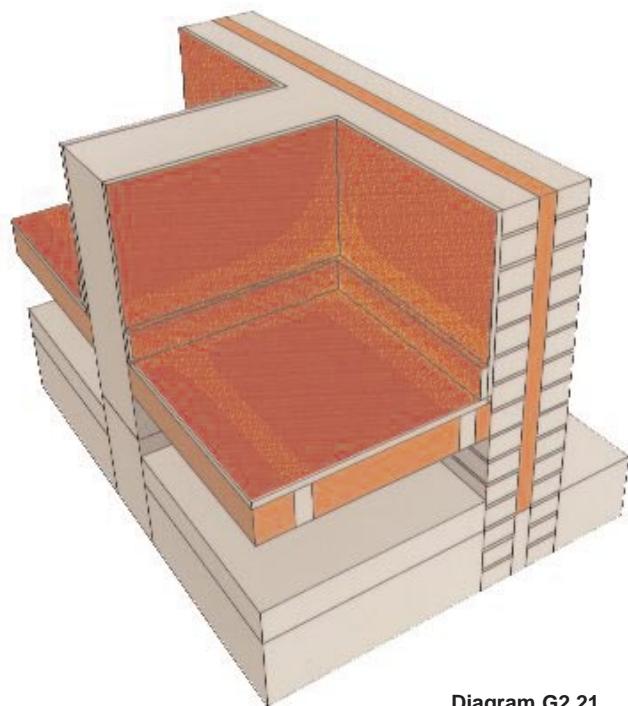


Diagram G2.21

### BEST PRACTICE

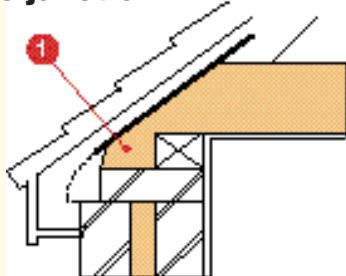
As with the corner detail in Diagram F2.20, the combination of cavity fill and floor insulation virtually eliminates thermal bridging.

The surface temperature at the junction of the separating wall and external wall is slightly warmer than the external corner in Diagram F2.20.

## Traditional cavity wall construction

### SUMMARY OF RECOMMENDATIONS – CAVITY INSULATION

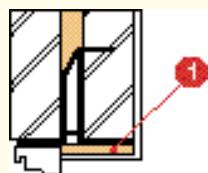
#### A Eaves junction



##### Best practice

- 1 Take the roof insulation over the wall plate and over the brick cavity closer if the construction permits.

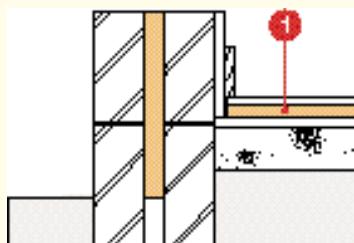
#### C Steel lintel junction



##### Minimum recommendations

- 1 Add insulation to soffit and reveals.

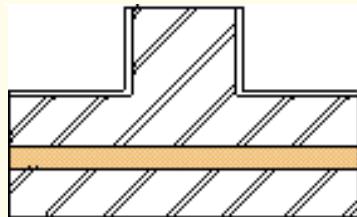
#### E Concrete ground floor junction



##### Best practice

- 1 Insulate the concrete floor.

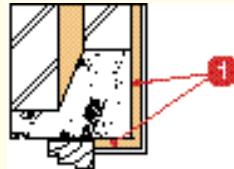
#### G Separating wall junction



##### Best practice

The cavity wall insulation is continuous.

#### B Lintel junction



##### Minimum recommendations

- 1 Add insulation to soffit, reveals and back of lintel.

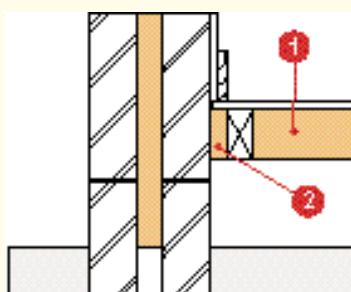
#### D Sill junction



##### Best practice

- 1 The insulation is taken up to the underside of the sill.

#### F Timber ground floor junction



##### Best practice

- 1 Specify floor insulation.
- 2 Insulate between last joist and wall.

**Note:** i) Minimum recommendations provide guidance on how to reduce the risk of mould growth.  
ii) Guidance on appropriate geographical locations for using cavity wall insulation can be obtained from BRE Report BR262, 1994 'Thermal insulation: avoiding risks'.

# Internal insulation added

Where cavity insulation is unsuitable, walls are usually insulated internally. The examples of internal insulation in this chapter assume that a 50 mm thick insulation/plasterboard laminate is adhesive fixed to the existing plaster finish. The insulant is assumed to be extruded polystyrene with a conductivity of 0.027 W/mK. This improves the U-value of a brick/cavity/brick wall from 1.5 W/m<sup>2</sup>K to about 0.47 W/m<sup>2</sup>K.

A

## EAVES JUNCTION – INTERNALLY INSULATED

### BEST PRACTICE

The combination of internal wall insulation and loft insulation eliminates the thermal bridge. When using internal insulation, it is not necessary to take the loft insulation over the top of the wall plate.

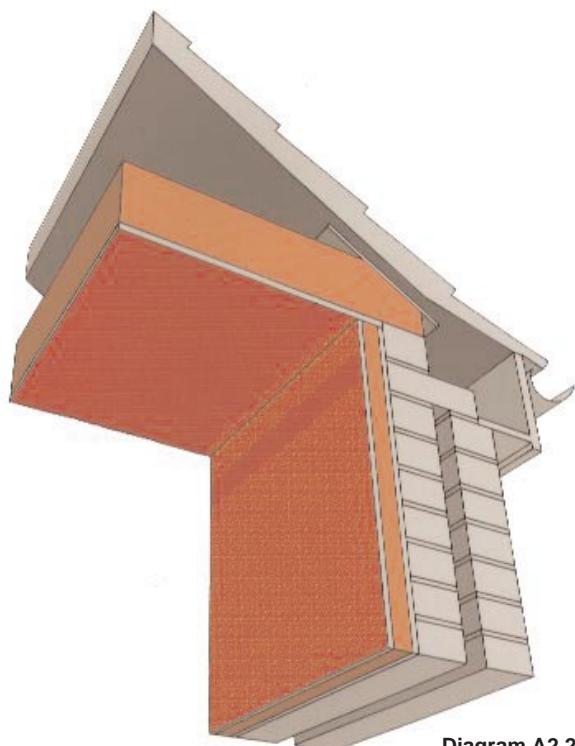


Diagram A2.22

### B BOOT LINTEL JUNCTION – INTERNALLY INSULATED

#### BEST PRACTICE

Adding internal wall insulation virtually eliminates thermal bridging. This example shows dry-lining with 13 mm of insulation returned into the soffit and reveal. If a thicker dry-lining board were used, it would mask the window frame.

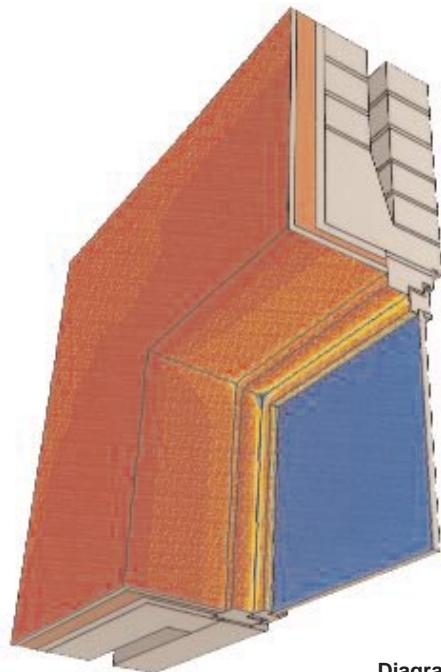


Diagram B2.23

### C STEEL LINTEL JUNCTION – INTERNALLY INSULATED

#### BEST PRACTICE

Surface temperatures are slightly higher with the steel lintel than with the boot lintel. The internal insulation eliminates thermal bridging.

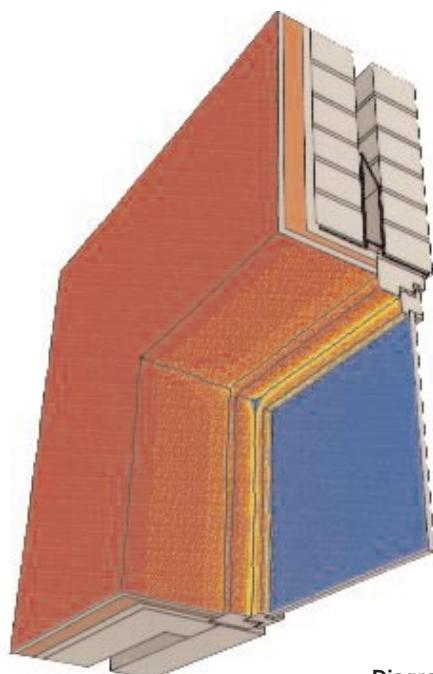


Diagram C2.24

## D SILL JUNCTION – INTERNALLY INSULATED

### SLIGHT RISK OF MOULD

Compared with the uninsulated wall, surface temperatures are considerably higher, but a small risk of mould growth still remains in the corner.

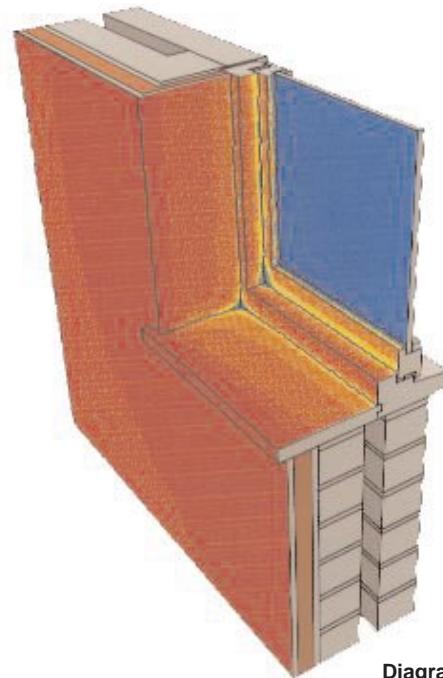


Diagram D2.25

*insulation  
added below  
window board*

### SLIGHT RISK OF MOULD

Adding insulation below the window board raises surface temperatures further, but still does not eliminate the small risk of mould growth in the corner.

Diagram D2.26

### E CONCRETE GROUND FLOOR JUNCTION – INTERNALLY INSULATED

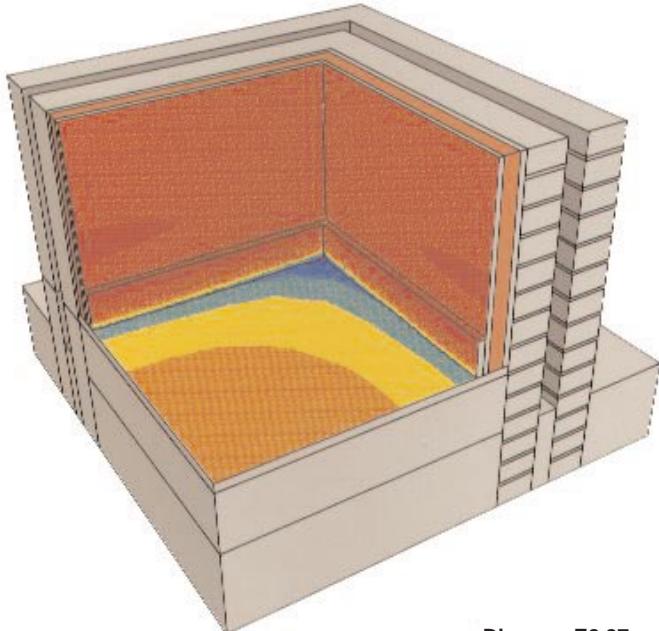


Diagram E2.27

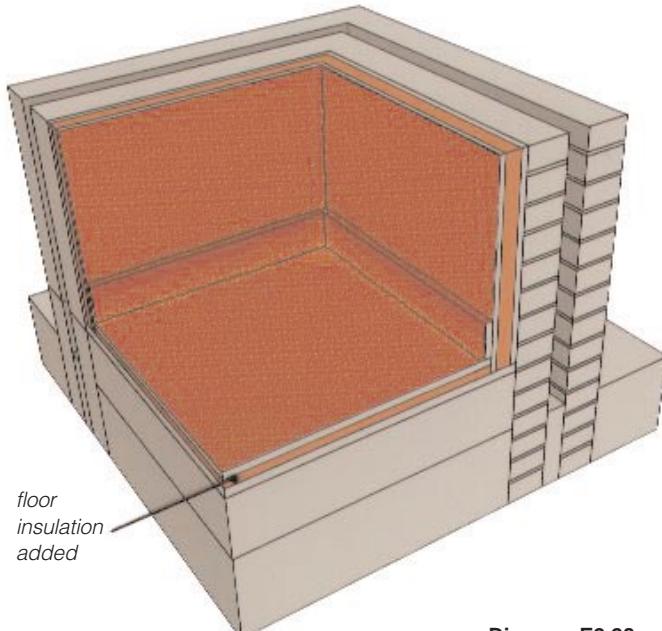


Diagram E2.28

#### MAJOR RISK OF MOULD

Adding insulation to the internal face of the wall has the effect of lowering the temperature of the inner leaf of the cavity wall. This in turn causes the temperature of the concrete slab to be colder than if the cavity was uninsulated (Diagram E2.5) and exacerbates the thermal bridge at the perimeter of the floor.

#### BEST PRACTICE

Adding as little as 25 mm of expanded polystyrene insulation to the floor increases surface temperatures dramatically and eliminates the thermal bridge. However, this would make it necessary to shorten internal doors and presents problems at the junction with the staircase.

### F TIMBER GROUND FLOOR JUNCTION – INTERNALLY INSULATED

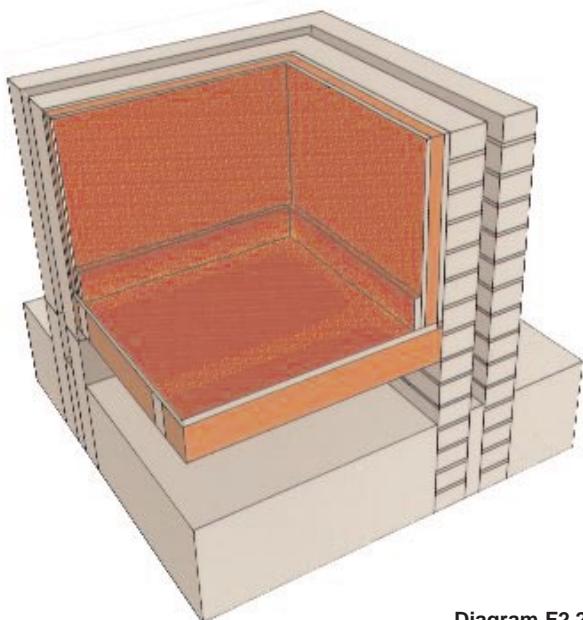


Diagram F2.29

#### BEST PRACTICE

The combination of insulated dry-lining and floor insulation avoids thermal bridging. This diagram may be compared with Diagram F2.6 which shows the effect of leaving the timber ground floor uninsulated.

## G

**SEPARATING WALL JUNCTION – INTERNALLY INSULATED****SLIGHT RISK OF MOULD** ➔

Adding internal wall insulation lowers the temperature of the inner leaf of the cavity wall. This in turn lowers the temperature of the separating wall at its junction with the cavity wall. Surface temperatures are low enough for there to be a small risk of mould growth above skirting level.

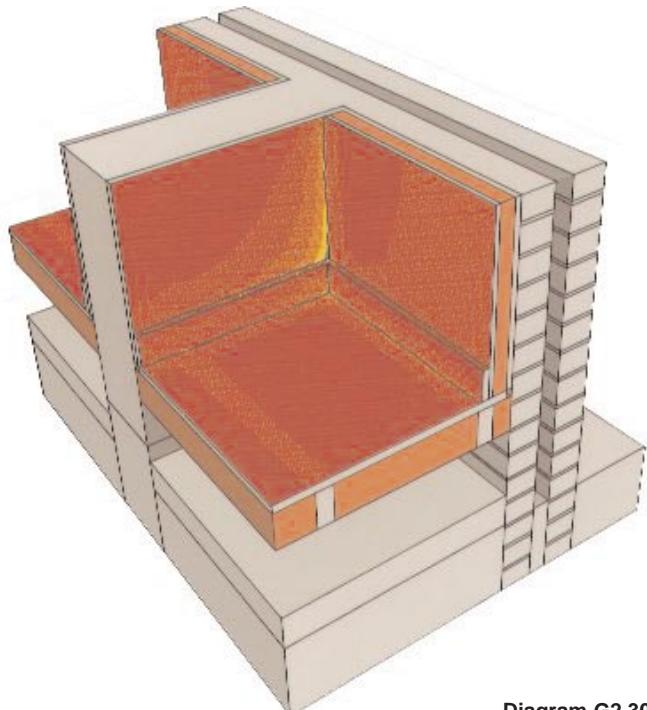


Diagram G2.30

*insulation added to separating wall*

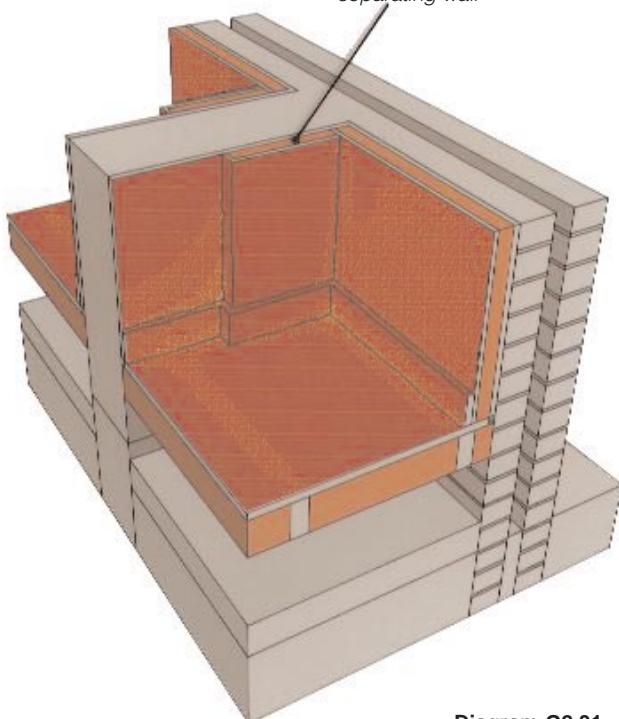


Diagram G2.31

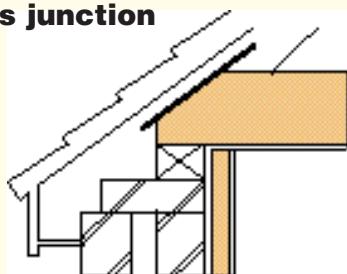
⬅ **BEST PRACTICE**

A 1000 mm wide band of dry-lining is returned along each side of the separating wall. This is sufficient to raise surface temperatures well above the level at which mould growth would be a risk.

## Traditional cavity wall construction

### SUMMARY OF RECOMMENDATIONS – INTERNAL INSULATION

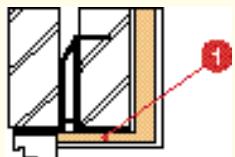
#### A Eaves junction



##### Best practice

The wall and roof insulation are continuous.

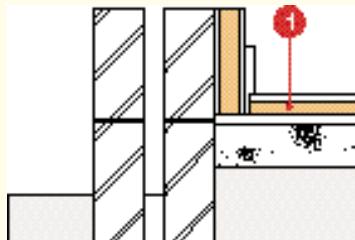
#### C Steel lintel junction



##### Best practice

1 Return dry-lining into soffit and reveals.

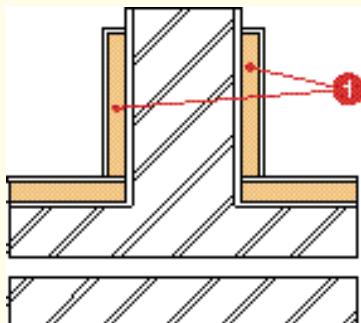
#### E Concrete ground floor junction



##### Best practice

1 Insulate the concrete floor.

#### G Separating wall junction



##### Best practice

1 Return the dry-lining at least 1000 mm along both sides of the separating wall (not shown to scale).

**Note:** Consideration should be given to the aesthetics of this detail. It may be preferable to cover the whole of the internal wall or stop the insulation at an acceptable point depending on room layout.

#### B Boot lintel junction



##### Best practice

1 Return dry-lining into soffit and reveals.

#### D Sill junction

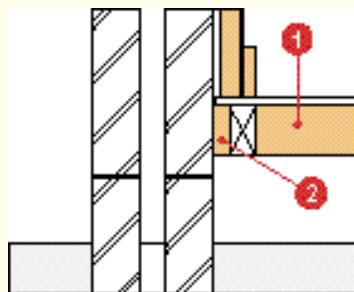


##### Minimum recommendations

1 Add insulation below windowboard.

**Note:** Slight risk of mould persists with detail D2.26, page 35.

#### F Timber ground floor junction



##### Best practice

1 Specify floor insulation.

2 Insulate between last joist and wall.

# Crosswall construction

In crosswall construction, the structural loads are carried by internal crosswalls of brick or concrete.

These usually form the separating walls between terraced houses or maisonettes. The external walls between the crosswalls are usually storey high infill panels of timber frame construction.

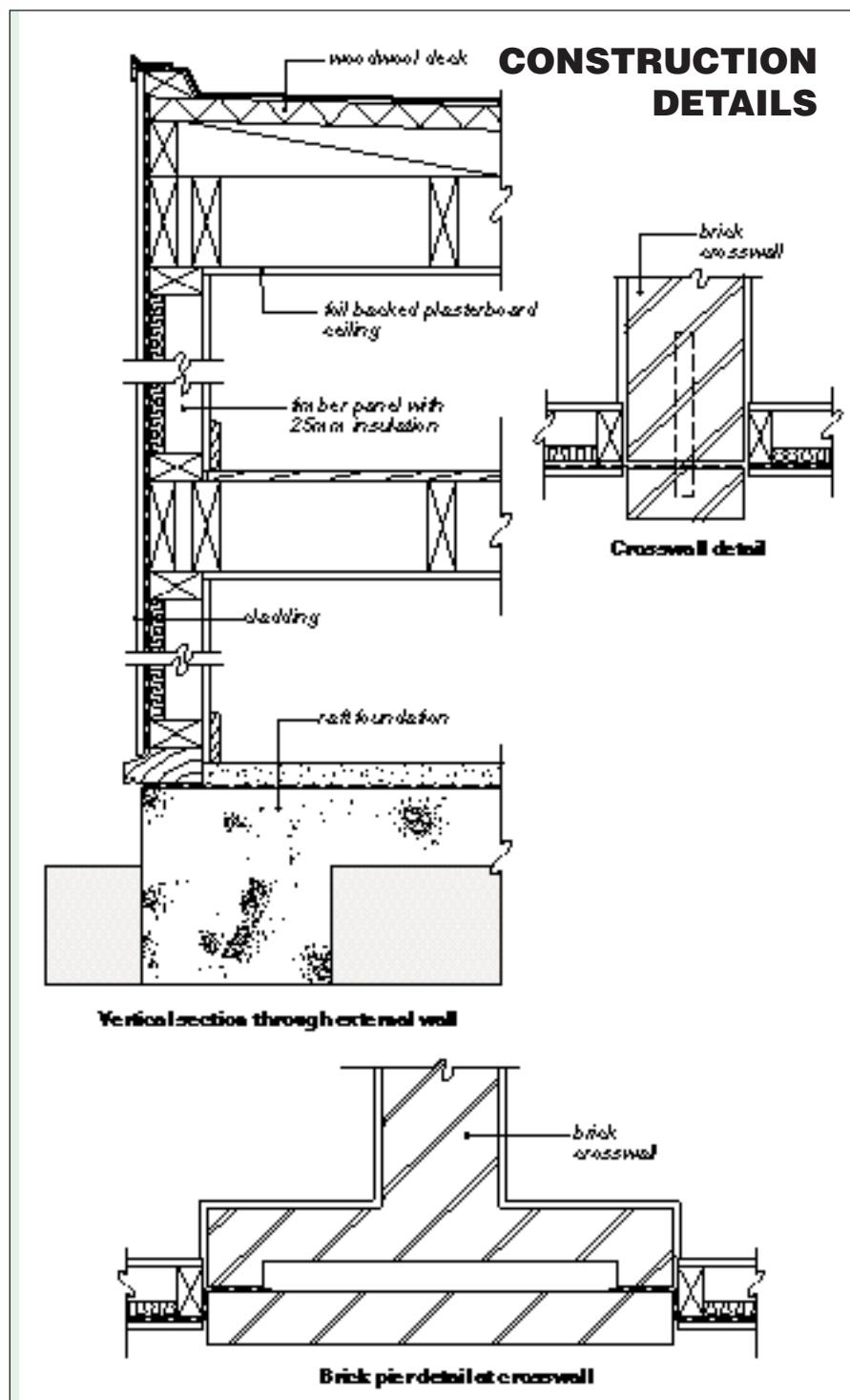
The details show a typical crosswall construction. The crosswall is 225 mm brickwork. Two alternative ways of finishing the crosswall are shown. In the upper detail, the crosswall is terminated by a single width of facing brick. The lower detail shows a brick pier. This was commonly used to improve the structural stability of the crosswall and reduce flanking sound transmission between dwellings. The gable end wall was usually constructed using traditional cavity brick construction.

Both flat and pitched roofs were used with crosswall construction. In the flat roof detail, shown here, the deck is constructed of woodwool slabs. In practice, a wide range of materials were used including strawboard and plywood. Using foil-backed plasterboard for the ceiling, the flat roof had a U-value between 0.8 and 1.00 W/m<sup>2</sup>K. Only flat roof construction is covered in this chapter.

The timber frame panels usually included about 25 mm of insulation, achieving a U-value of 0.7 to 0.9 W/m<sup>2</sup>K, depending on the type of cladding used. These U-values are better than those of contemporary masonry cavity wall construction in the 1960s and early 1970s.

Ground floors were usually of concrete. The use of lightweight infill construction meant that a raft foundation was often used where ground conditions permitted.

The relatively good level of insulation in the flat roof and the walls results in a low risk of mould growth on the internal surfaces of these elements. The thermal analyses on the next two pages show that the main thermal bridge is at the floor perimeter, particularly at the edge of the raft foundation. The remaining pages in this chapter show the effect of adding further insulation.



# Uninsulated construction

**A**

### EAVES JUNCTION

The use of foil-backed plasterboard for the ceiling, combined with a woodwool deck for the flat roof, is sufficient to avoid a risk of mould growth. However, there is a thermal bridge at the junction of the timber frame panel with the ceiling and crosswall.

The most serious risk with this construction is not surface mould, but interstitial condensation in the roof void. The thermal analyses show that the underside of the woodwool deck can fall to below 5°C in the corner of the roof void, with a risk of condensation if moisture from the dwelling is able to enter the roof void.

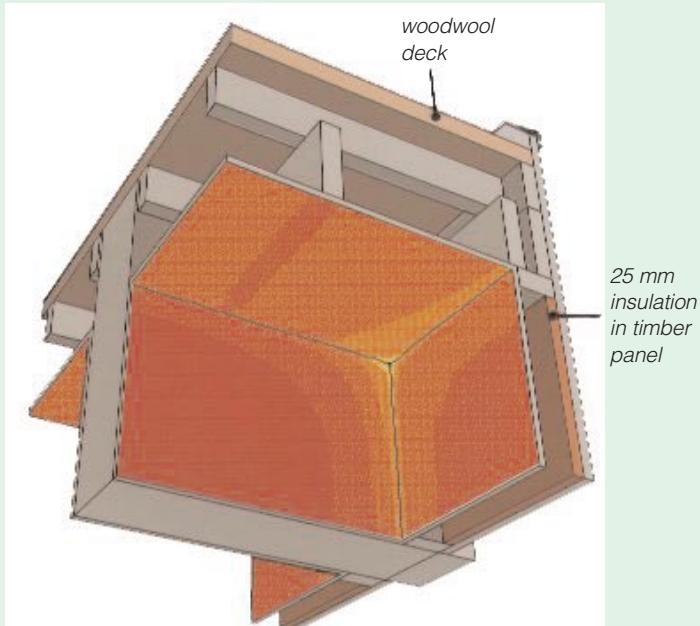


Diagram A3.1

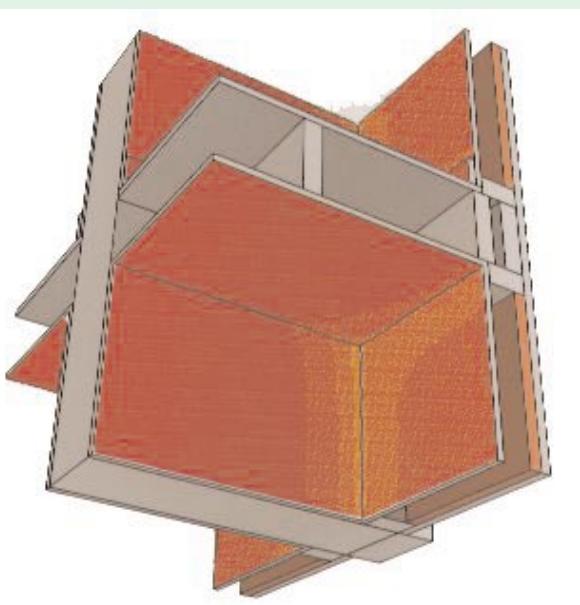


Diagram B3.2

**B**

### CROSSWALL JUNCTION

The projection of the brick crosswall to the outside results in a thermal bridge at the junction of the separating wall and the timber panel.

**C****BRICK PIER JUNCTION**

The surface temperatures are lower when the separating wall abuts a brick cavity wall pier, than when it projects as a simple crosswall. This is because the heat loss through the brick pier is greater than through the timber panel.

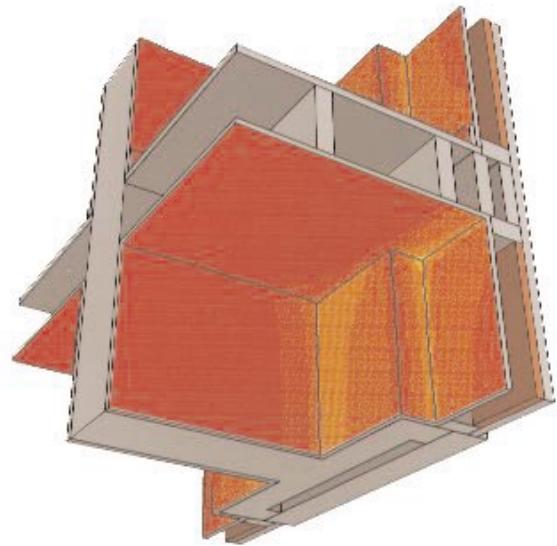


Diagram C3.3

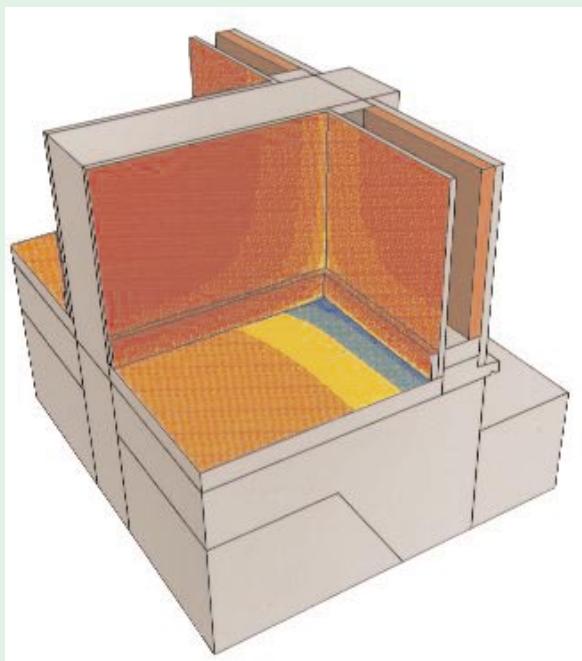


Diagram D3.4

**CROSSWALL GROUND FLOOR JUNCTION****D**

This construction shows a raft foundation, which was commonly used with crosswall construction. The thermal bridge at the floor perimeter is far more severe than at the brick crosswall. There is a high risk of mould growth.

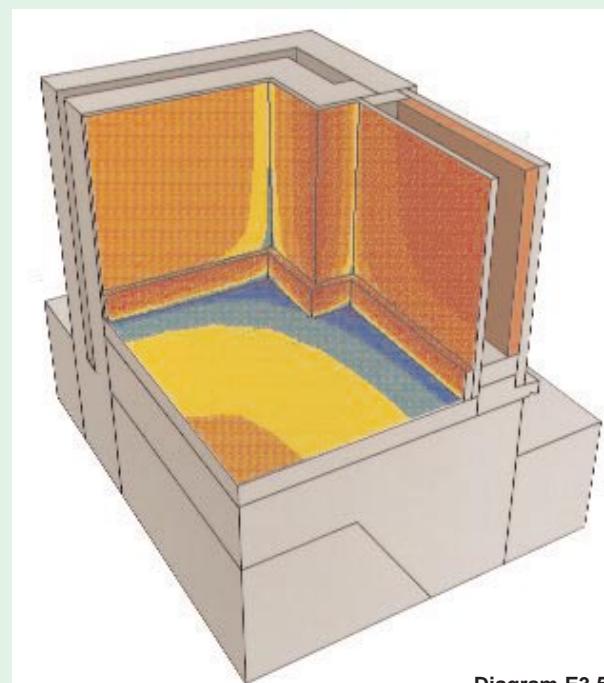


Diagram E3.5

**E****GABLE WALL JUNCTION**

As with junction D, the thermal bridge at the floor perimeter is far more severe than at the corner of the brick cavity wall, resulting in a high risk of mould growth.

# Insulation added

With crosswall construction, the main insulation option is to add cavity insulation and upgrade the level of insulation in the flat roof and timber framed panels.

Where the walls are unsuitable for cavity fill, internal insulation would be a viable alternative.

Upgrading the insulation of the flat roof is normally carried out when the roof covering is renewed. The examples in this chapter assume a new roof deck and an insulation

board with a thermal resistance of  $2.5 \text{ m}^2\text{K/W}$ , giving a U-value of about  $0.35 \text{ W/m}^2\text{K}$ .

Upgrading the insulation in the timber panels from 25 mm to 90 mm improves the U-value to about  $0.37 \text{ W/m}^2\text{K}$ , depending on the type of cladding. The insulation can be installed when the cladding is being renewed. The timber panels should include a vapour control layer on the warm side of the insulation, to minimise the risk of interstitial condensation.

## A EAVES JUNCTION – INSULATION ADDED

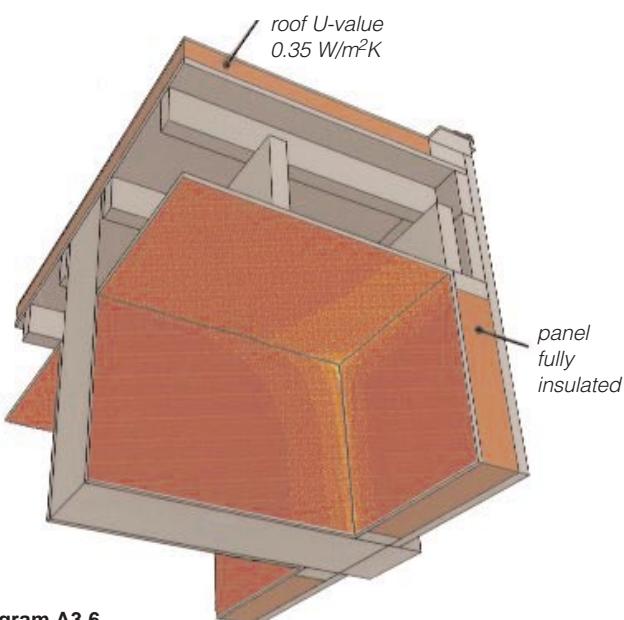


Diagram A3.6

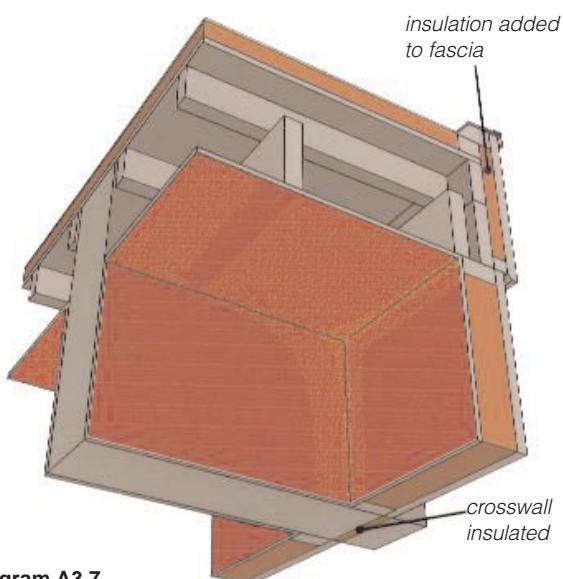


Diagram A3.7

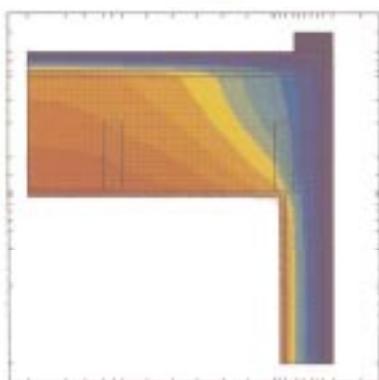


Diagram A3.6A

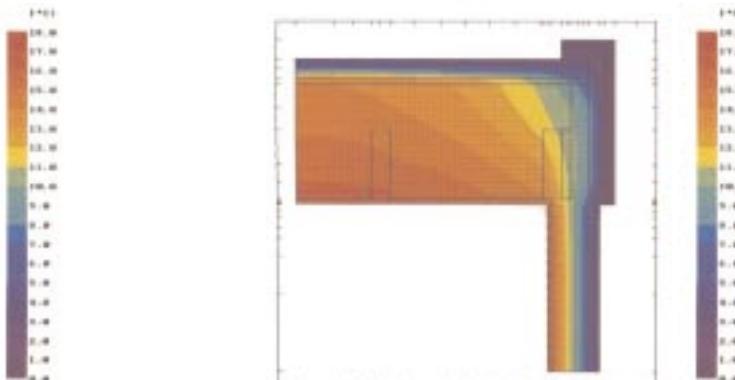


Diagram A3.7A

### Thermal bridge

Improving the insulation standards of the roof and filling the timber frame panels with insulation not only increases surface temperatures in the dwelling, but also raises the temperature in the roof void. However, the thermal bridge at the crosswall remains.

### Best practice

This example eliminates the thermal bridge at the crosswall by placing a 20 mm strip of extruded polystyrene at the vertical dpc position in the crosswall. To achieve this, the outer brick fin would need to be removed and rebuilt incorporating the insulation.

If external cladding is being renewed, there is the opportunity to add insulation behind the new fascia as shown in Diagram A3.7. This helps to provide continuity between the wall and roof insulation. Diagram A3.7A shows that, compared with Diagram A3.6A, the temperature in the corner of the roof void is about  $3^\circ\text{C}$  warmer.

## B CROSSWALL JUNCTION – INSULATION ADDED

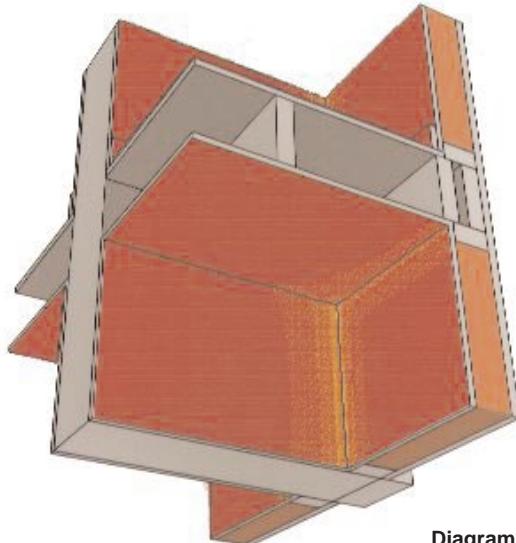


Diagram B3.8

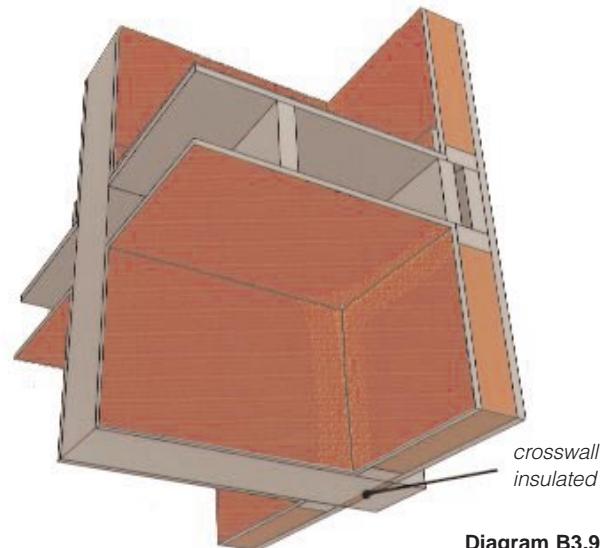


Diagram B3.9

### THERMAL BRIDGE

Filling the timber frame panels with insulation raises their surface temperature substantially, but has no impact on the thermal bridge at the crosswall. There should be a vapour control layer on the warm side of the panel insulation to avoid the risk of interstitial condensation.

### BEST PRACTICE

In Diagram B3.9, the thermal bridge at the crosswall is eliminated by placing a 20 mm layer of expanded polystyrene at the vertical dpc position in the crosswall. To achieve this would require the outer brick fin to be removed and rebuilt with the insulation incorporated.

## C BRICK PIER JUNCTION – INSULATION ADDED

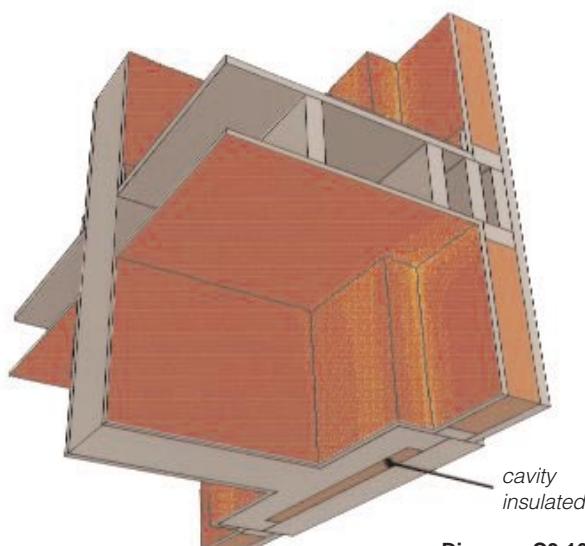


Diagram C3.10

### THERMAL BRIDGE

Although the brick piers in crosswall construction are usually narrow, filling them with cavity insulation virtually eliminates thermal bridging through the external walls. The small remaining thermal bridge at the brick pier/panel junction is not easy to eliminate unless the timber panels are being replaced. If they are, consideration should be given to inserting a strip of insulation at the jamb return.

### D GROUND FLOOR JUNCTION – INSULATION ADDED

#### MAJOR RISK OF MOULD

Filling the timber frame panel with insulation has negligible effect on the main thermal bridges through the floor and crosswall.

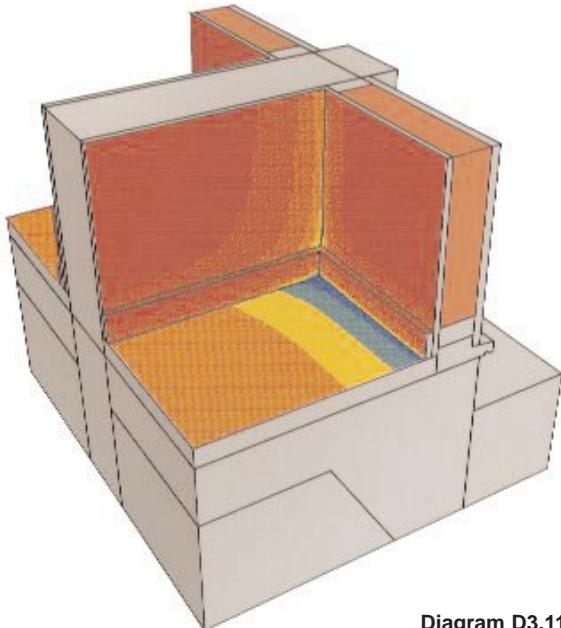


Diagram D3.11

#### SLIGHT RISK OF MOULD

As shown in earlier examples, adding insulation at the crosswall eliminates the thermal bridge at this point. Adding external perimeter insulation to the edge of the concrete raft foundation raises the temperature of the floor slab significantly. This solution is worth considering if adding insulation to the ground floor is not feasible.

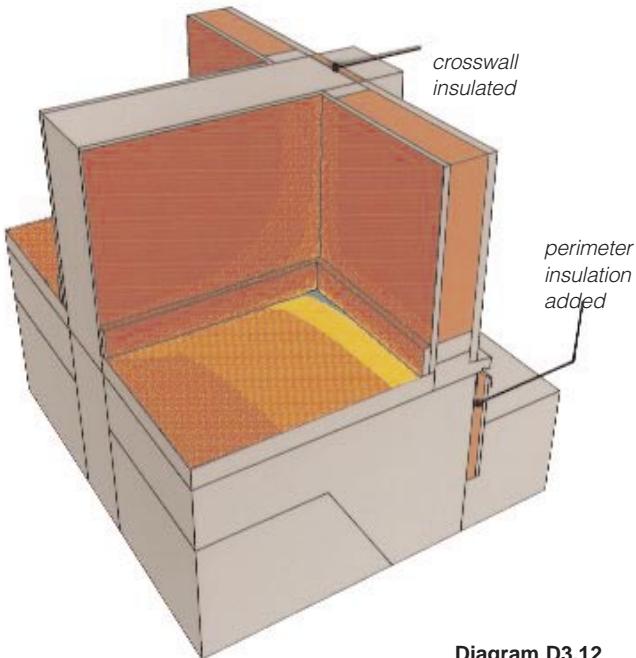


Diagram D3.12

#### BEST PRACTICE

Adding 25 mm of expanded polystyrene with a chipboard finish creates a much warmer floor surface than does perimeter insulation. However, this may not be a practical option. Internal doors would need to be shortened and there are problems at the junction with the staircase.

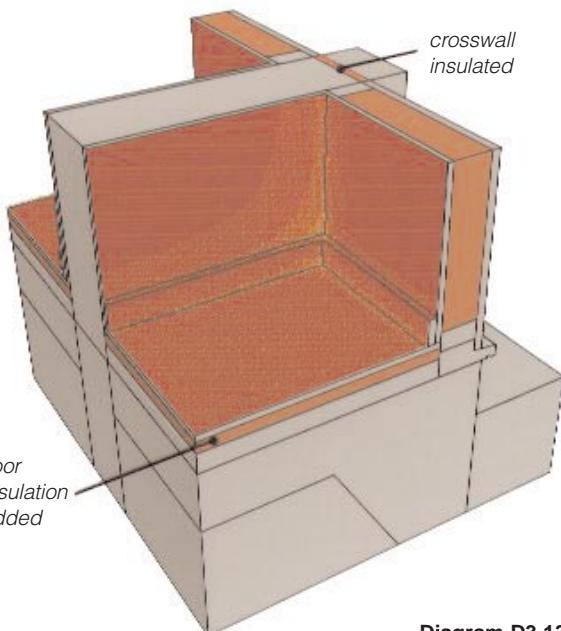


Diagram D3.13

E

## GABLE WALL JUNCTION – INSULATION ADDED

### MAJOR RISK OF MOULD

As for junction C, there is a small thermal bridge at the brickwork/panel junction. This is not easy to overcome without replacing the timber panel.

A much greater thermal bridge occurs at the floor perimeter, where there is a high risk of mould growth.

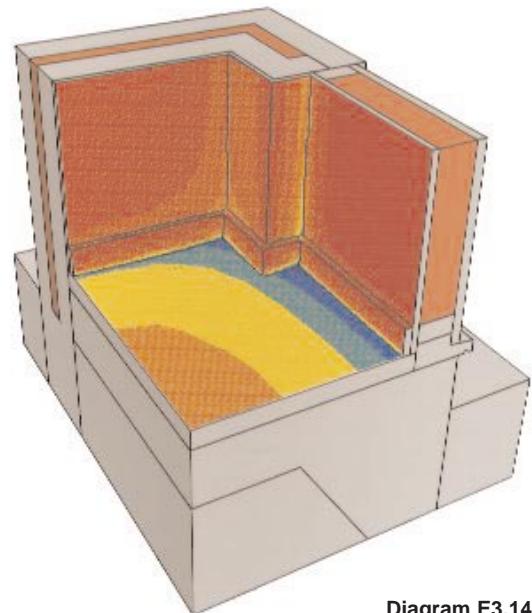


Diagram E3.14

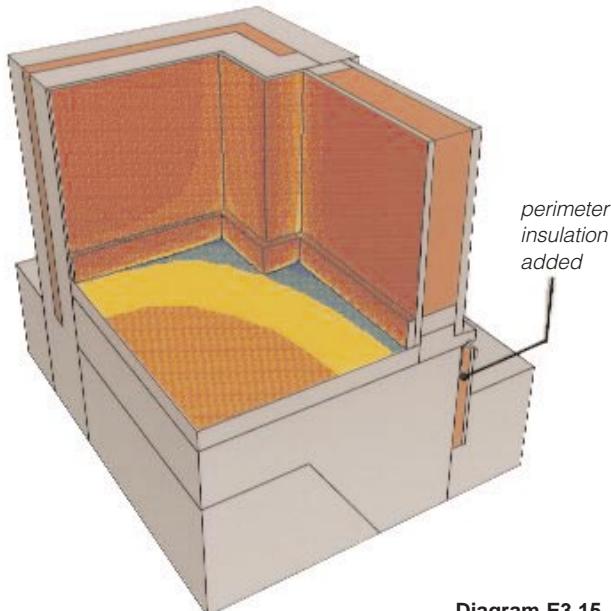


Diagram E3.15

### RISK OF MOULD

Perimeter insulation raises surface temperatures by about 1°C, but does not prevent a serious risk of mould growth. Extending the depth of the perimeter insulation would reduce, but not eliminate, the risk of mould growth.

### MINOR THERMAL BRIDGE

As in Diagram D3.13 adding 25 mm of polystyrene insulation above the floor eliminates the thermal bridge through the ground floor concrete raft, but there are practical problems with raising the floor level.

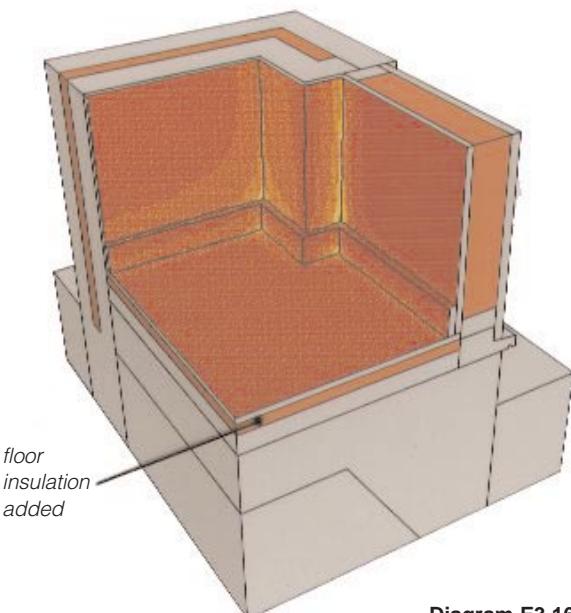
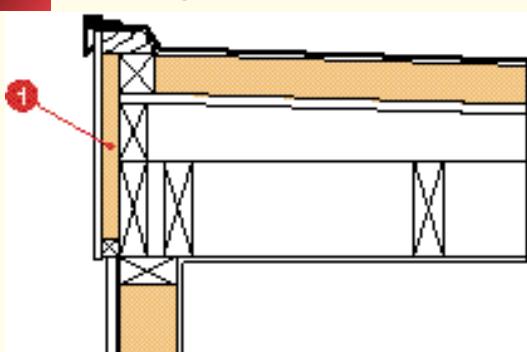


Diagram E3.16

## Crosswall construction

### SUMMARY OF RECOMMENDATIONS – INSULATION ADDED

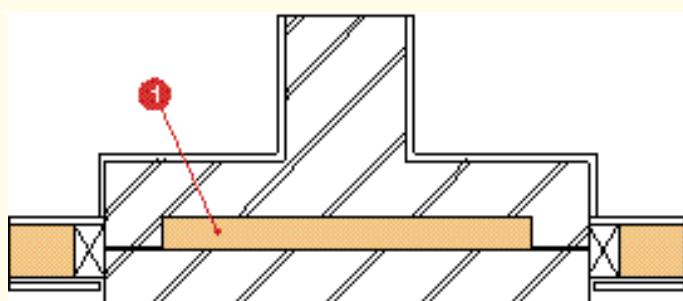
#### A Eaves junction



##### Best practice

- 1 Insulate fascia to provide continuity between roof and wall insulation.

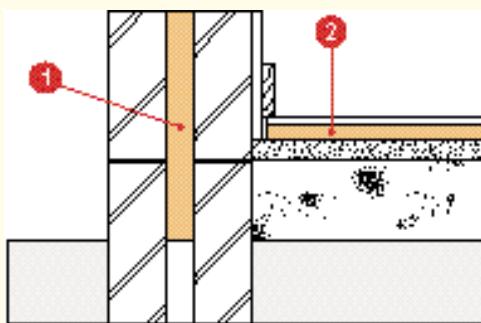
#### C Brick pier junction



##### Minimum recommendations

- 1 Add cavity insulation to the brick pier.

#### E Gable end junction



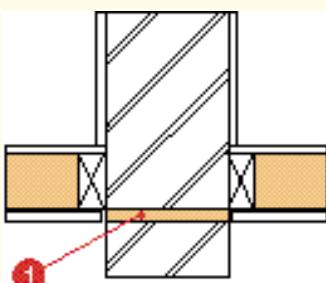
##### Minimum recommendations

- 1 Add cavity insulation to gable walls.
- 2 Insulate the concrete floor.

**Notes:** i) Minimum recommendations provide guidance on how to reduce the risk of mould growth.

ii) Guidance on appropriate geographical locations for using cavity wall insulation can be obtained from BRE Report BR262, 1994 'Thermal insulation: avoiding risks'.

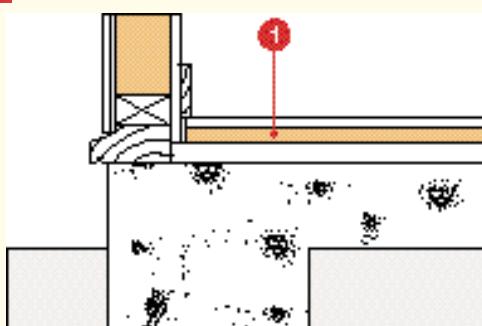
#### B Crosswall junction



##### Best practice

- 1 Insulate the end of the crosswall.

#### D Ground floor junction



##### Best practice

- 1 Insulate the concrete floor.

# Concrete frame construction

This form of construction was used both for low-rise balcony access schemes and for high-rise tower blocks. The concrete frame and floor slabs were usually cast in-situ.

Construction details vary from one scheme to another. The details shown here are typical of a low-rise balcony access scheme built in the early 1970s. The spacing of the concrete columns coincides with the separating walls. The columns are set back behind the outer skin of brickwork, but interrupt the cavity.

The brick cavity walls are supported by the concrete ring beam at each floor level. Where there are brick cavity walls above and below the concrete ring beam, it is faced in brick slips. Elsewhere it is exposed externally.

The example shows a concrete flat roof, although timber flat roofs are equally common. A 25 mm layer of fibreboard is located below the asphalt, giving a U-value of about 1.2 W/m<sup>2</sup>K.

The brick cavity walls with a medium density block for the inner leaf achieve a U-value of about 1.4 W/m<sup>2</sup>K. Infill timber panels incorporating 25 mm of glassfibre insulation achieve a U-value of about 0.9 W/m<sup>2</sup>K.

An insulating screed is used below the asphalt finish to the balcony access walkway, achieving a U-value of about 1.4 W/m<sup>2</sup>K.

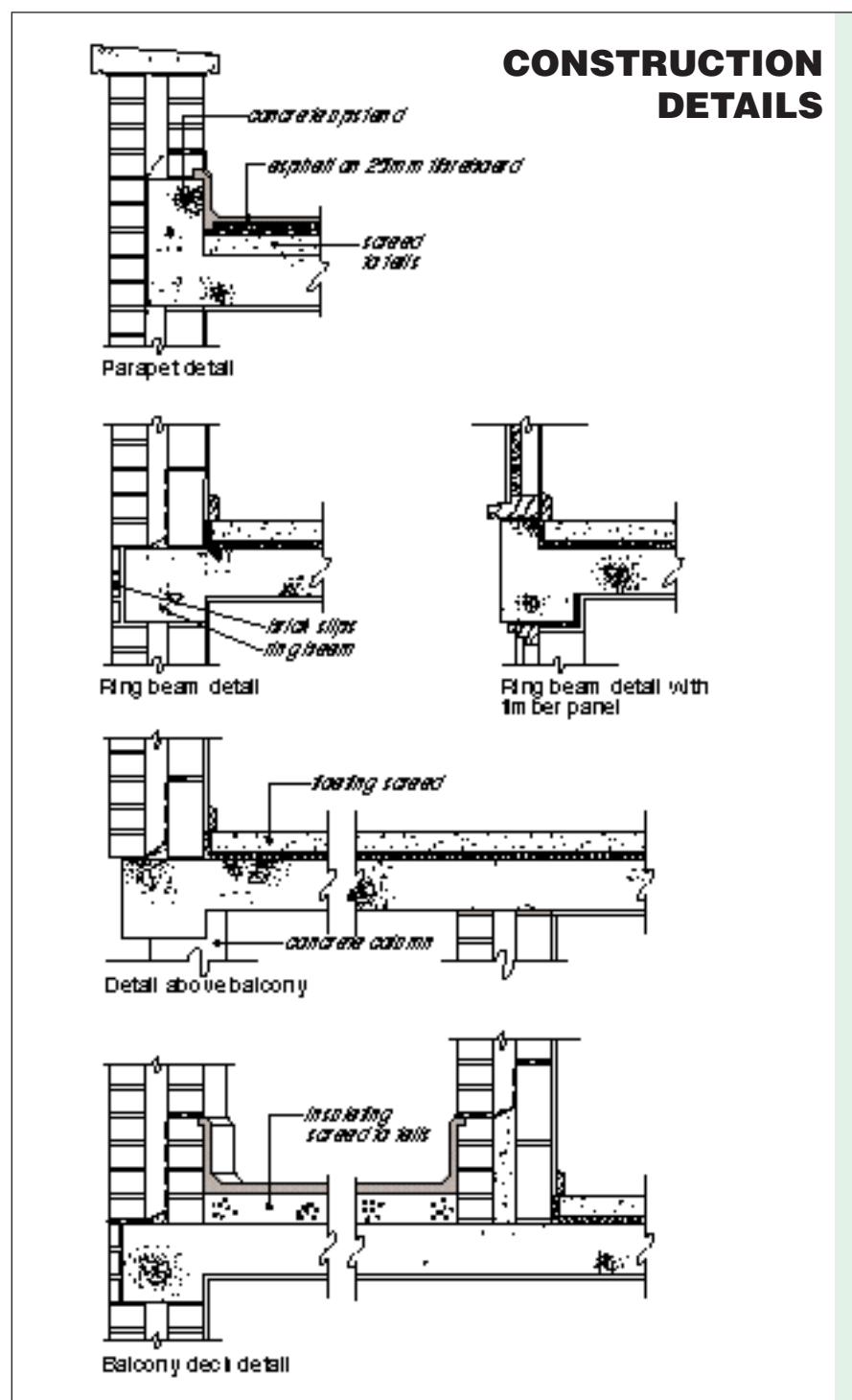
These U-values are better than the requirements of the Building Regulations before 1976 and are typical of this form of construction in the early 1970s.

Apart from incorporating 13 mm of expanded polystyrene at the concrete ring beam above the windows, little attention was paid to avoiding the multiple thermal bridges which occur at the junction of the concrete structure and external brick walls.

The following two pages show the thermal analyses of the main junctions of the existing construction. The remaining pages in this chapter show the effect of insulating the structure using three alternative methods:

- cavity insulation
- internal insulation using insulated dry-lining
- external insulation.

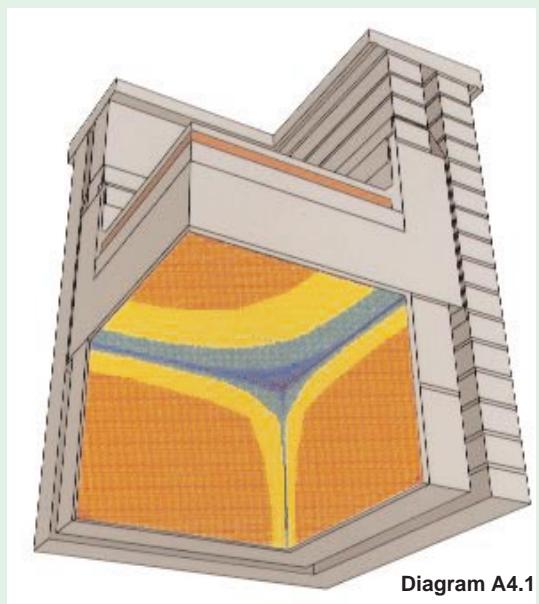
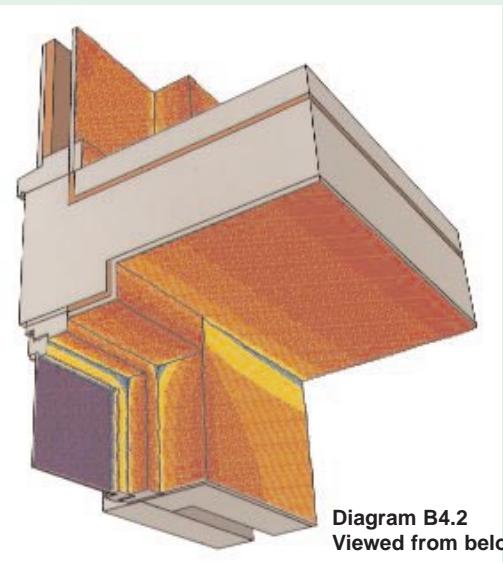
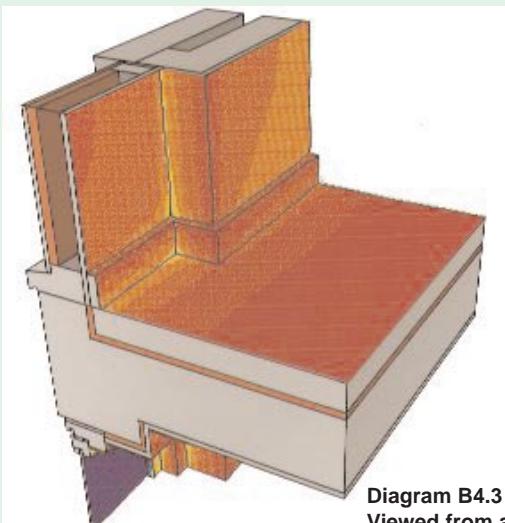
Due to the complexity of the thermal bridge paths, it is sometimes necessary to use a combination of insulation methods.



# Uninsulated construction

**A****FLAT ROOF JUNCTION**

The thermal bridge through the concrete upstand beam results in a serious risk of mould growth at the edge of the ceiling, particularly in the corner.

**Diagram A4.1****Diagram B4.2**  
Viewed from below**Diagram B4.3**  
Viewed from above**INFILL PANEL JUNCTIONS****B**

In Diagrams B4.2 and B4.3, the concrete downstand beam has 13 mm of polystyrene insulation to reduce the effect of the thermal bridge. The coldest surfaces are at the junction of the cavity wall with the floor slab, and in the top corner of the window frame.

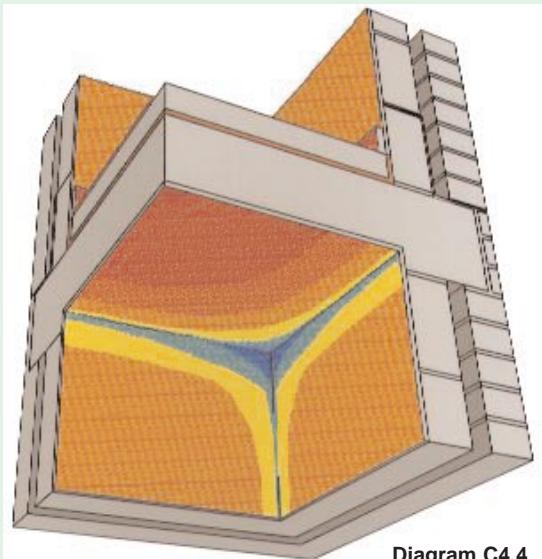
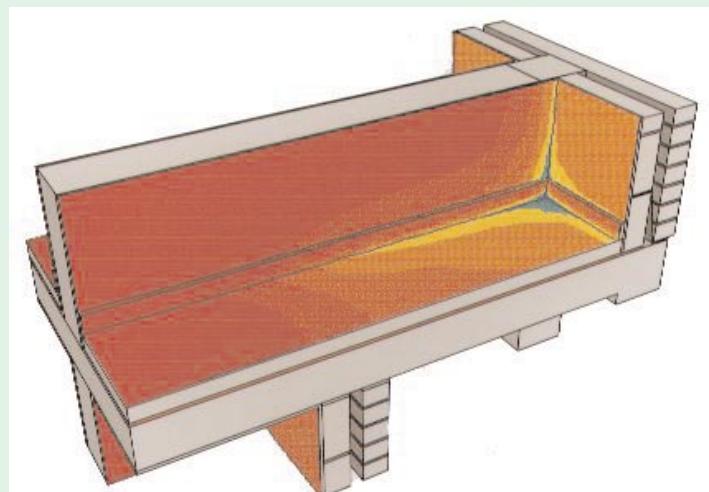


Diagram C4.4

## RING BEAM JUNCTION

C

The risk of mould growth at the ring beam is less severe than at roof level. This is despite the thermal bridge appearing to be just as acute. The reason for this is that the floor slab, unlike the roof slab, receives heat from above. The upper surface of the floor slab is almost at room temperature, whilst the upper surface of the roof slab is less than 5°C at the external corners.

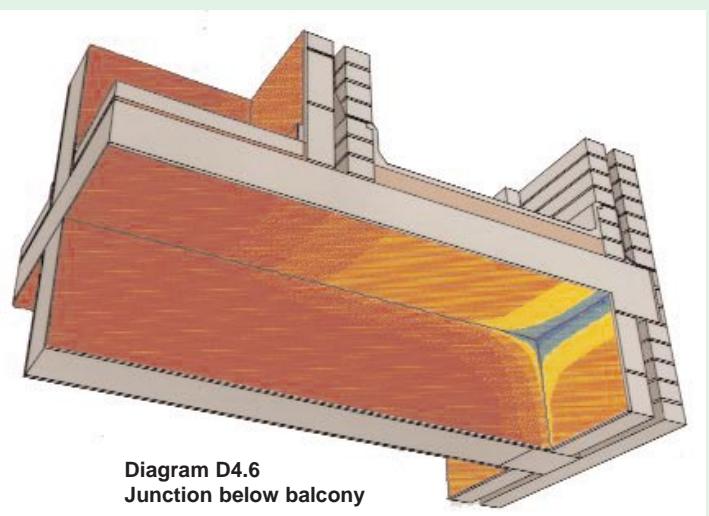
Diagram D4.5  
Junction above balcony

D

## BALCONY JUNCTIONS

In Diagram D4.5, the thermal bridge through the slab over the balcony is most severe near the junction with the concrete column. The area of green indicates a risk of mould growth in the corner.

In Diagram D4.6, the U-value through the balcony slab is 1.4 W/m<sup>2</sup>K, about the same as through the unfilled cavity wall. The high risk of mould growth at the edge of the ceiling is due to the thermal bridge through the concrete edge beam.

Diagram D4.6  
Junction below balcony

# Cavity wall insulation added

The majority of cavity wall insulation systems have Agrément certificates for buildings up to 12 m high. Cavity wall insulation can be installed in buildings more than 12 m high subject to survey. This would involve opening up the cavity to check that cavity trays are installed correctly and to clear any debris from the cavity.

Filling the cavity with insulation reduces the U-value to between 0.35 and 0.55 W/m<sup>2</sup>K.

depending on the density of the block used for the inner leaf and the cavity width. The cavity filled walls in this chapter are assumed to have a 50 mm wide cavity and a medium density block for the inner leaf, achieving a U-value of 0.53 W/m<sup>2</sup>K.

Upgrading the insulation in the timber framed panels from 25 mm to 90 mm improves the U-value from about 0.9 W/m<sup>2</sup>K to about 0.4 W/m<sup>2</sup>K.

## A ROOF JUNCTION – CAVITY INSULATED

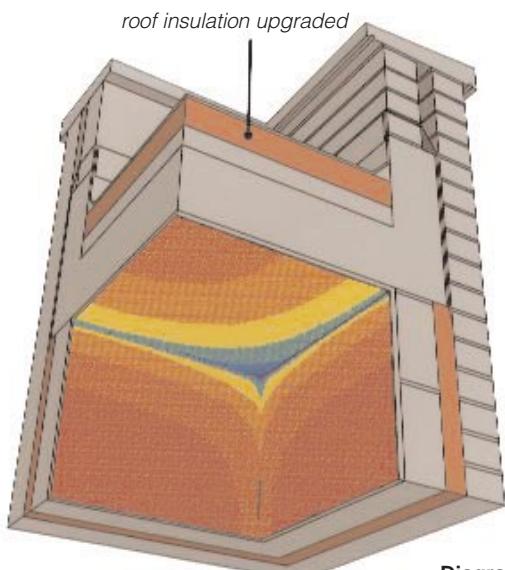


Diagram A4.7

### MAJOR RISK OF MOULD

Despite having cavity wall insulation and the roof insulation improved to give a U-value of 0.35 W/m<sup>2</sup>K, there is still a risk of mould growth at the edge of the ceiling. This is because the thermal bridge through the concrete upstand beam is still intact.

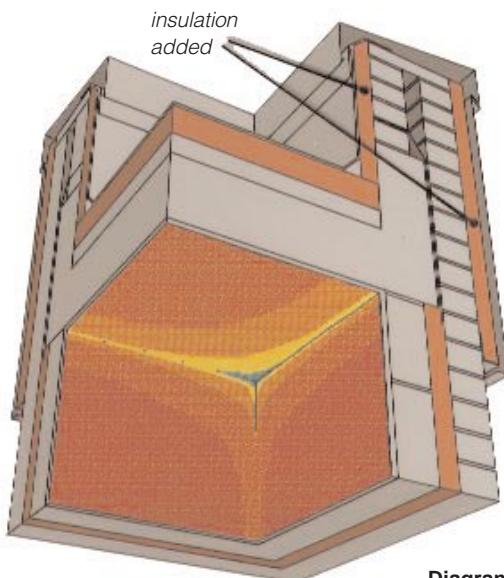


Diagram A4.8

### SLIGHT RISK OF MOULD

Adding external insulation as shown extends the length of the heat loss path and results in significantly higher temperatures at the ceiling/wall junction and a consequently lower risk of mould growth. The external insulation would need to be protected with a render or some form of overcladding.

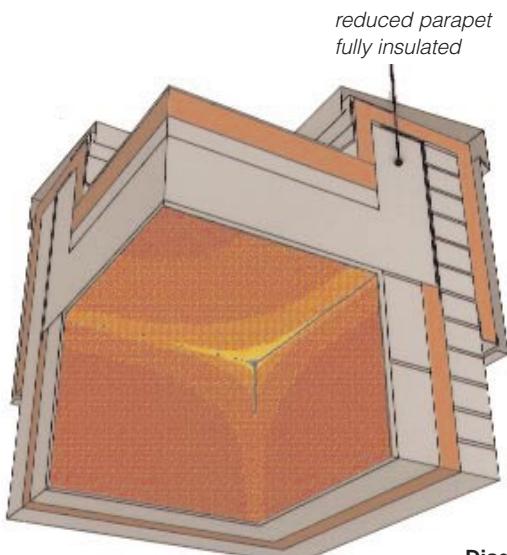


Diagram A4.9

### SLIGHT RISK OF MOULD

Reducing the height of the parapet and extending the insulation over it increases temperatures further and almost eliminates the risk of mould growth in the corner.

## B INFILL PANEL JUNCTION – CAVITY INSULATED

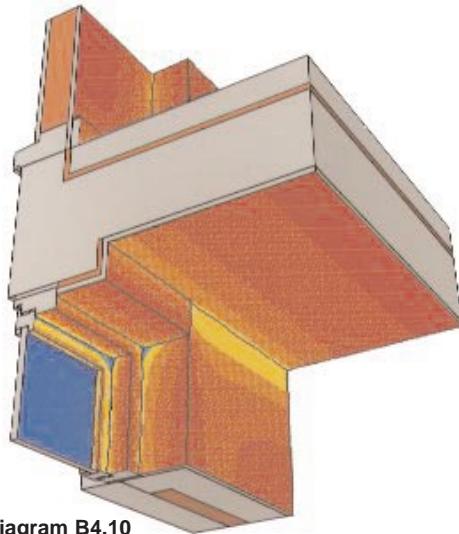


Diagram B4.10  
Viewed from below

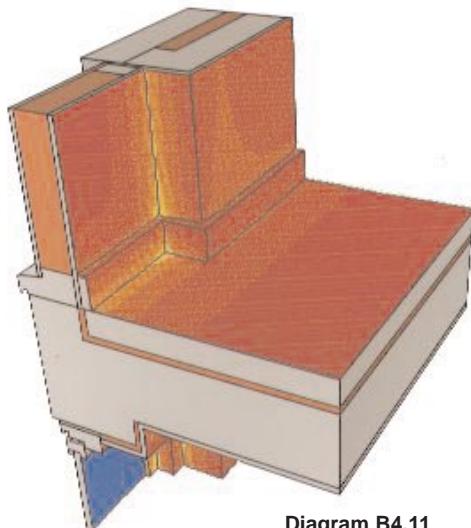


Diagram B4.11  
Viewed from above

### MAJOR THERMAL BRIDGE

Diagrams B4.10 and B4.11 show the effect of adding cavity insulation and increasing the thickness of the panel insulation to 90 mm. The extra insulation raises the surface temperature sufficiently to reduce the risk of mould growth. However, the thermal bridge through the concrete edge beam still remains.

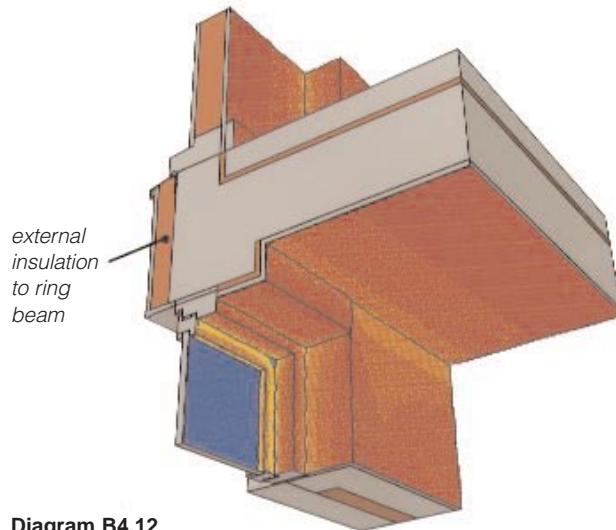


Diagram B4.12

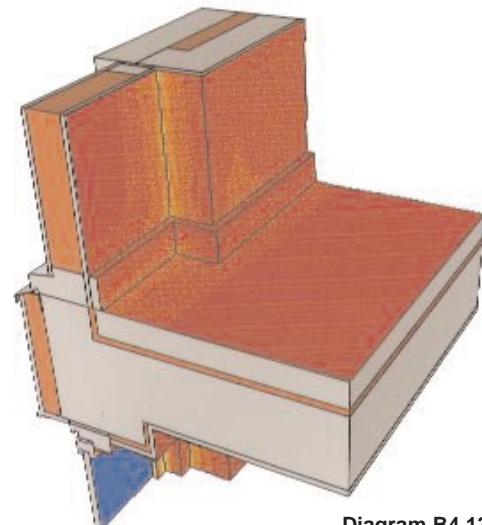


Diagram B4.13

### MINOR THERMAL BRIDGES

Adding 50 mm of external insulation to the ring beam raises surface temperatures significantly and greatly reduces the effect of the thermal bridge. The external insulation would need to be protected with a render or some form of overcladding.

### C RING BEAM JUNCTION – CAVITY INSULATED

#### MAJOR RISK OF MOULD

The addition of cavity wall insulation raises the surface temperature of the main wall areas, but has little effect on the thermal bridge through the ring beam.

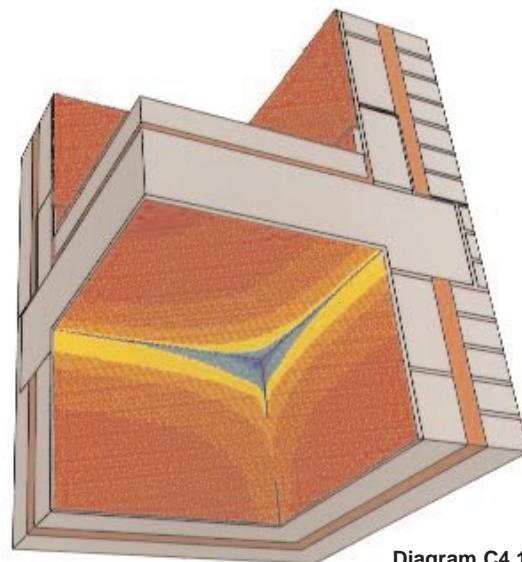


Diagram C4.14

#### RISK OF MOULD

Replacing the brick slips with 25 mm of insulation and a render finish helps to reduce the severity of the thermal bridge and thus the risk of mould growth.

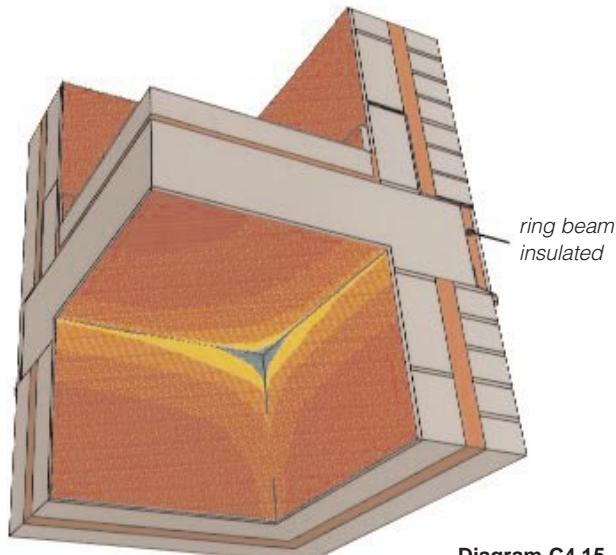


Diagram C4.15

#### SLIGHT RISK OF MOULD

A further marginal improvement in surface temperatures can be achieved by adding external insulation to the ring beam. This would create a projecting string course at each floor level and would need to be carefully detailed to avoid rain penetration.

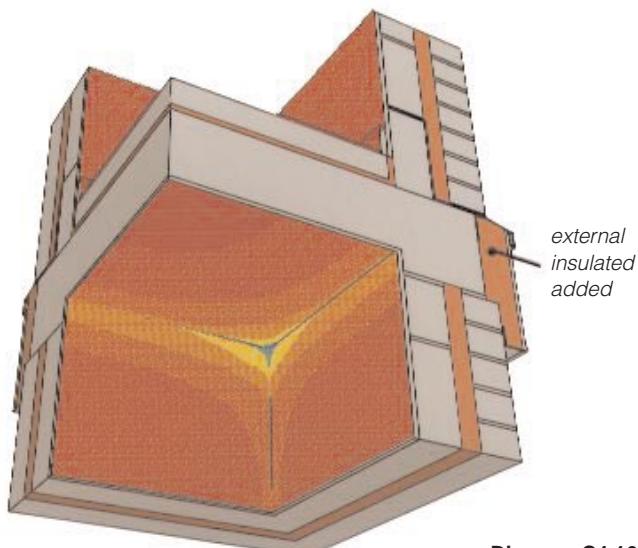


Diagram C4.16

## D BALCONY JUNCTIONS – CAVITY INSULATED

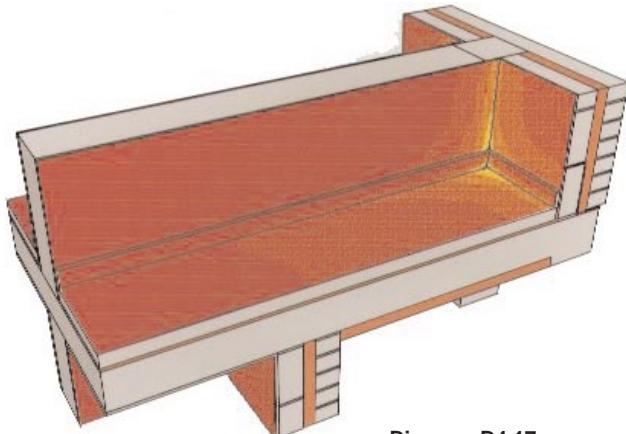


Diagram D4.17  
Junction above balcony

### MAJOR RISK OF MOULD

In Diagram D4.17, the addition of cavity wall insulation and under-slab insulation raises surface temperatures substantially, but the thermal bridges through the column and edge beam still present a major risk of mould growth.

In Diagram D4.18, the addition of cavity insulation has little effect on the thermal bridge through the ring beam.

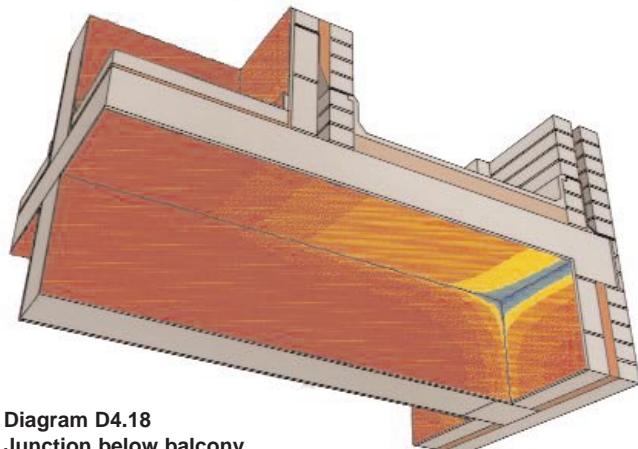


Diagram D4.18  
Junction below balcony

### SLIGHT RISK OF MOULD

In Diagram D4.19, adding insulation to the edge beam avoids a thermal bridge through this part of the structure. The lower temperatures at the corner of the floor are due to the thermal bridge through the concrete column.

In Diagram D4.20, the combination of insulation to the balcony walkway and the ring beam substantially reduces the severity of the thermal bridge, but there remains a slight risk of mould growth. Externally the ring beam insulation, as in Diagram C4.16, shows only a marginal reduction in the risk of mould growth.

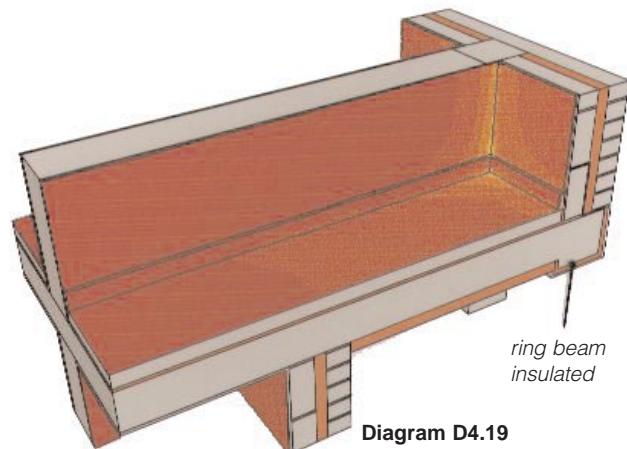


Diagram D4.19  
Junction above balcony

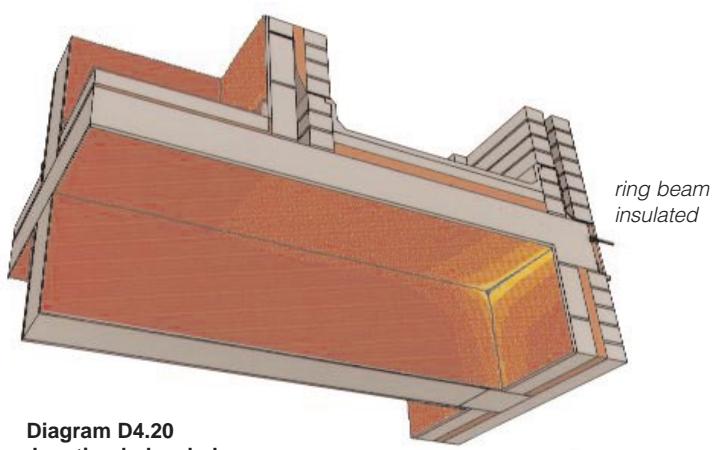
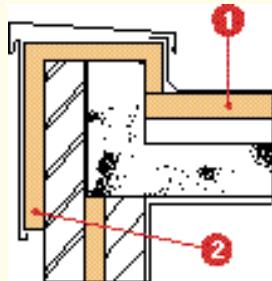


Diagram D4.20  
Junction below balcony

### SUMMARY OF RECOMMENDATIONS – CAVITY INSULATED

#### A Roof junction

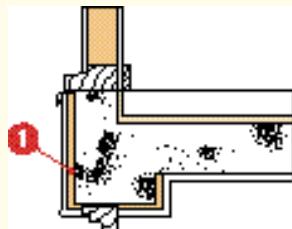


##### Minimum recommendations

- 1 Insulate roof.
- 2 Insulate parapet to link wall and roof insulation.

**Note:** Slight risk of mould persists with detail A4.9, page 50.

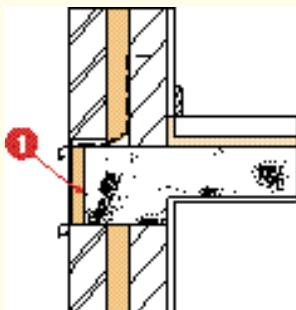
#### B Infill panel junction



##### Minimum recommendations

- 1 Insulate edge of ring beam.

#### C Ring beam junction

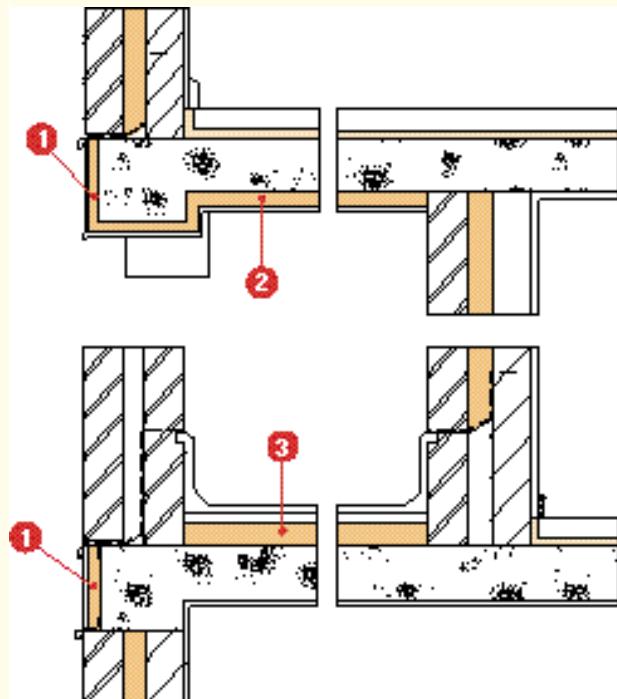


##### Minimum recommendations

- 1 Insulate edge of ring beam.

**Note:** Slight risk of mould persists with detail C4.16, page 52.

#### D Balcony junction



##### Minimum recommendations

- 1 Insulate edge of ring beam.
- 2 Insulate underside of exposed concrete.
- 3 Insulate underside of balcony deck.

**Note:** Slight risk of mould persists with detail D4.20, page 53.

# Internal wall insulation added

The examples in this chapter show a 50 mm thick insulated dry-lining, adhesive fixed to the existing plaster. The insulant has a conductivity of 0.027 W/mK. This improves the U-value of the existing cavity wall from about 1.4 W/m<sup>2</sup>K to about 0.46 W/m<sup>2</sup>K.

With this form of construction, the use of an insulated dry-lining alone is not sufficient to avoid all thermal bridge problems. The examples show dry-lining in combination with external insulation at some junctions.

A

## EAVES JUNCTION – INTERNALLY INSULATED

### MAJOR RISK OF MOULD

Although the internal surfaces are warmer as a result of adding the roof and wall insulation, there is still a high risk of mould growth at the edge of the ceiling. This is because the thermal bridge through the concrete upstand beam is still present.

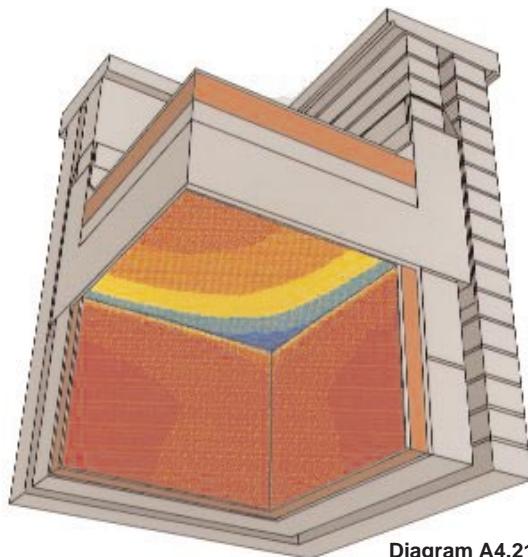


Diagram A4.21

ceiling insulation  
added at roof  
perimeter

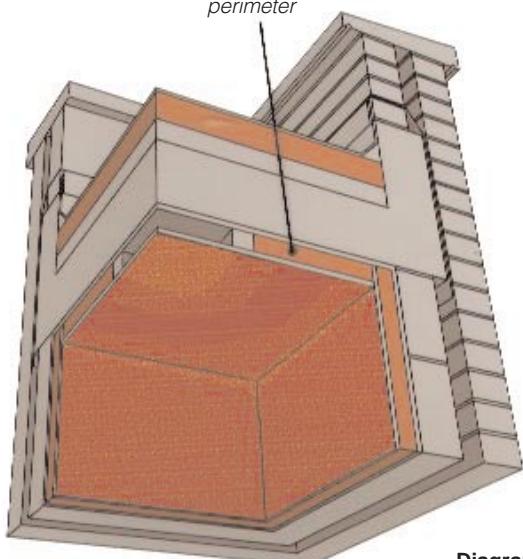


Diagram A4.22

### NO THERMAL BRIDGE

The most effective way to avoid the risk of mould growth at ceiling level is to add a new plasterboard ceiling, with insulation to the ceiling perimeter. However, the risk of interstitial condensation occurring within the cold roof slab is high. This detail is only recommended, therefore, where an effective vapour control layer can be provided at the new ceiling level.

### B INFILL PANEL JUNCTION – INTERNALLY INSULATED

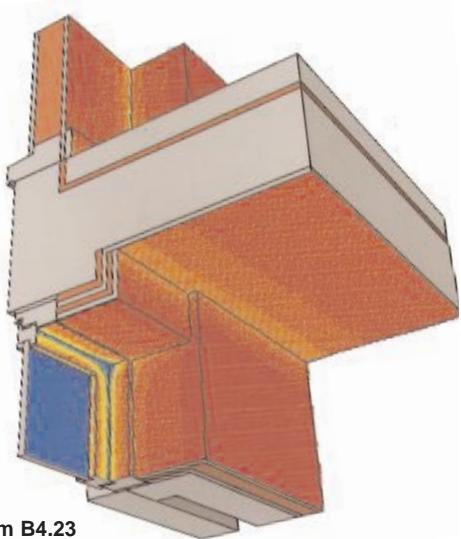


Diagram B4.23  
Viewed from below

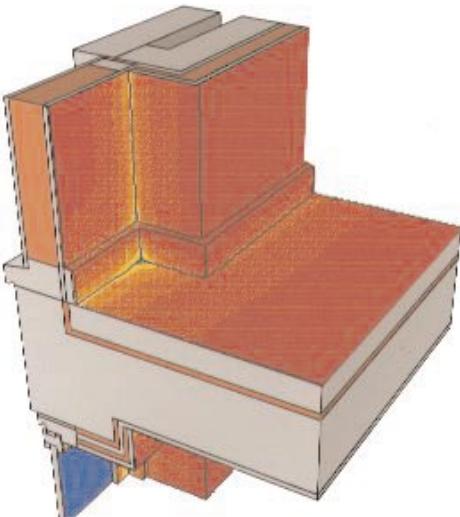


Diagram B4.24  
Viewed from above

#### THERMAL BRIDGE

Diagrams B4.23 and B4.24 show the combined effect of adding an insulated dry-lining, topping up the panel insulation to 90 mm in thickness and adding double glazing. The coldest surfaces occur at floor level, immediately behind the infill panel. Adding insulation at ceiling level to overcome the thermal bridge at that point would increase the risk of mould growth occurring on the floor above.

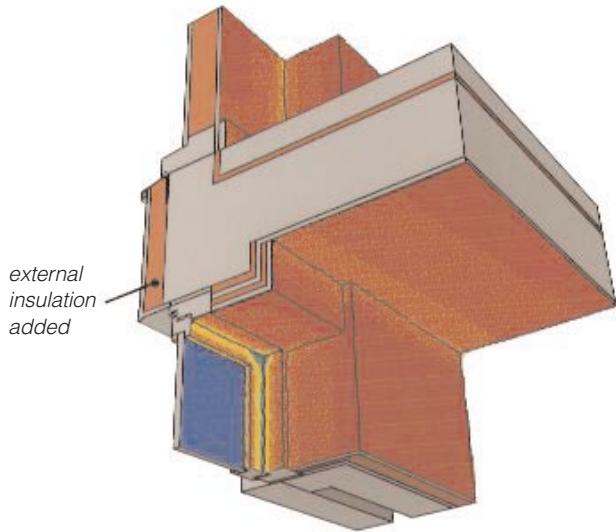


Diagram B4.25

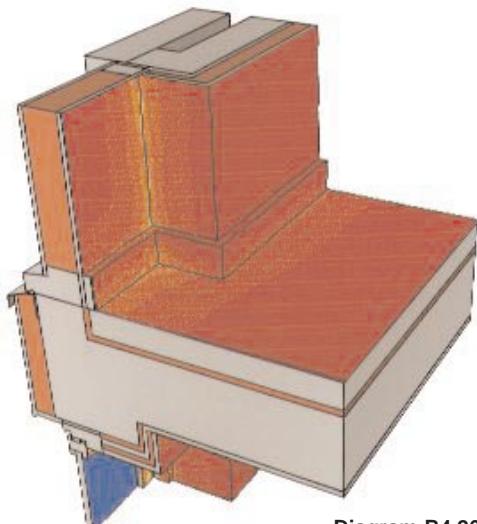


Diagram B4.26

#### MINOR THERMAL BRIDGE

Insulating the exposed edge of the ring beam as shown in Diagrams B4.25 and B4.26, virtually eliminates the thermal bridge and raises surface temperatures sufficiently for there to be little risk of mould growth.

## C RING BEAM JUNCTION – INTERNALLY INSULATED

### RISK OF MOULD

As at roof level, the insulated dry-lining raises the surface temperature of the main wall area, but the thermal bridge through the concrete ring beam still presents a mould growth risk at the corner of the ceiling.

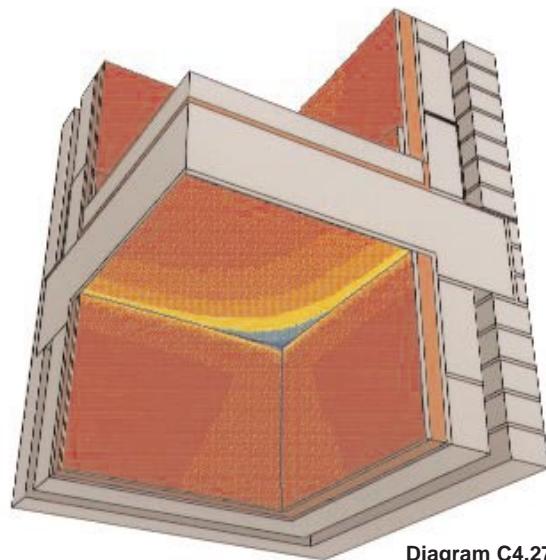


Diagram C4.27

*ceiling  
insulation  
added*

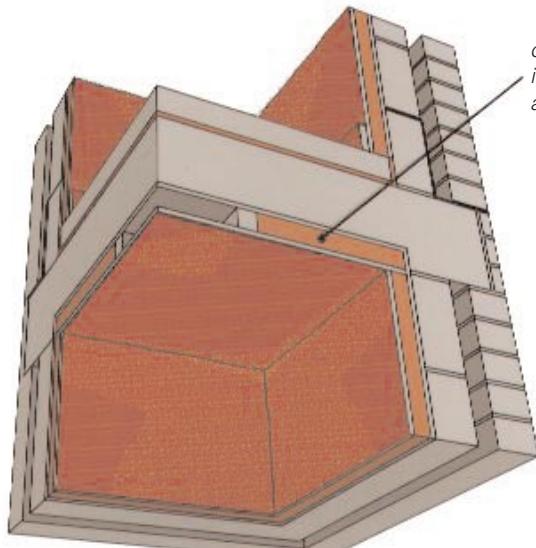


Diagram C4.28

### BEST PRACTICE

Adding a false plasterboard ceiling backed with perimeter insulation avoids the mould growth risk at the ceiling. The new ceiling should contain a vapour control layer. The perimeter insulation should be not more than 300 mm wide, or there is a risk of chilling the upper floor surface to a point at which mould growth might occur.

### D BALCONY JUNCTIONS – INTERNALLY INSULATED

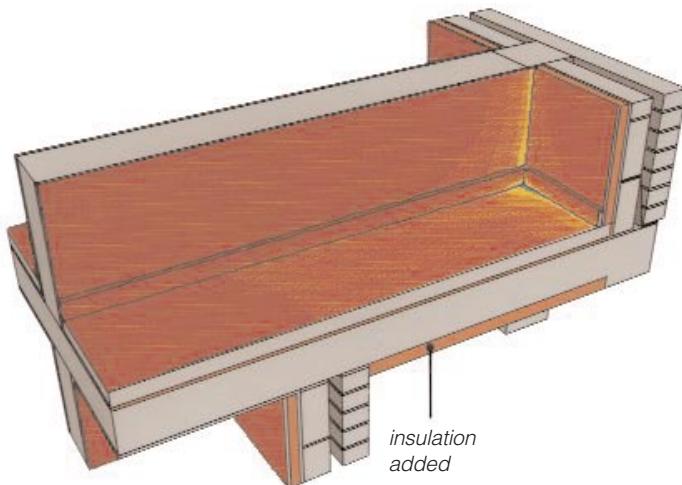


Diagram D4.29  
Junction above balcony

#### RISK OF MOULD

In Diagram D4.29, the addition of an insulated dry-lining and under-slab insulation raises surface temperatures, but the thermal bridges through the column and edge beam still present a risk of mould growth at the corner of the floor.

In Diagram D4.30, the insulated dry-lining raises the surface temperature of the external walls and ceiling, but increases the risk of mould growth occurring at the edge of the separating wall.

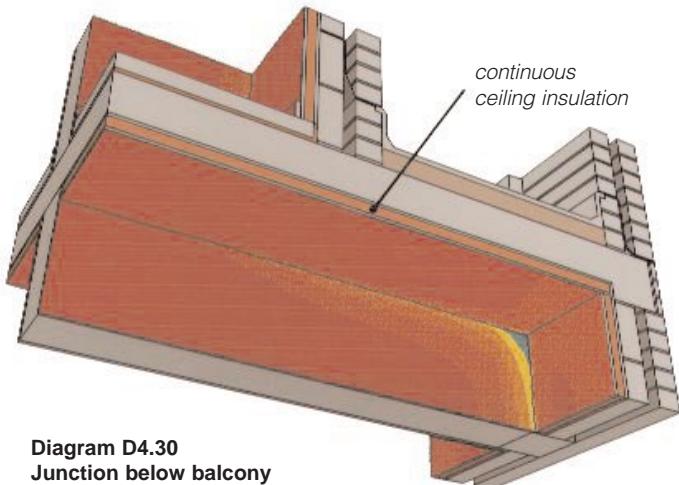
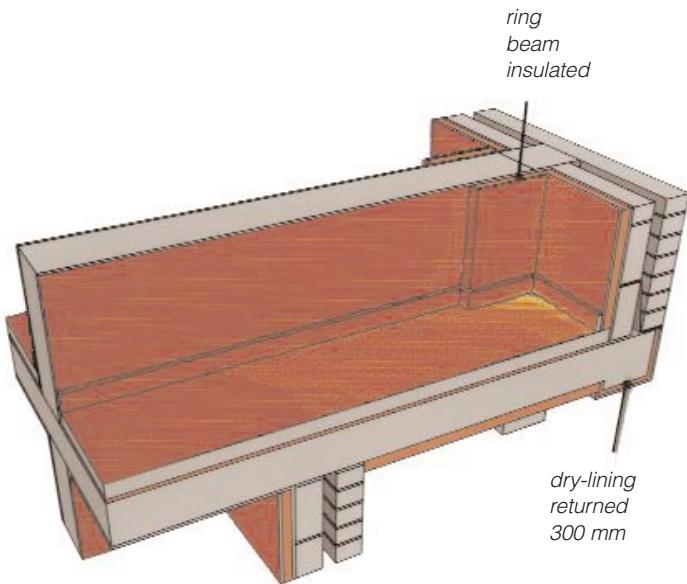


Diagram D4.30  
Junction below balcony

## D BALCONY JUNCTIONS

### ***continued***

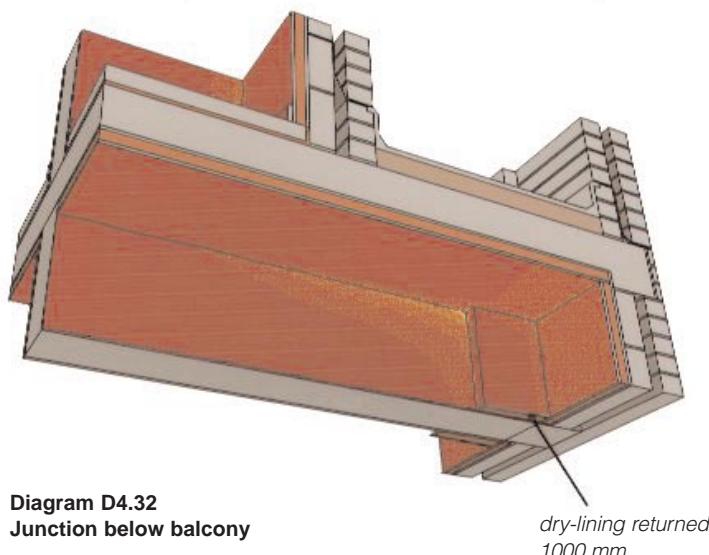


**Diagram D4.31**  
Junction above balcony

#### SLIGHT RISK OF MOULD

Adding the insulation as in Diagram D4.31 reduces the severity of the thermal bridge through the concrete column but still leaves a small risk of mould growth at the corner of the floor. This could only be avoided by providing continuity between the insulated dry-lining and an extra strip of insulation placed above the floor slab. This would involve taking up the floor screed.

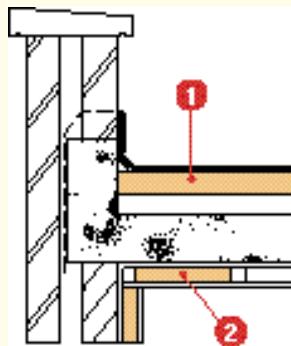
In Diagram D4.32, returning the insulated dry-lining reduces the risk of mould growth, but there is still a thermal bridge through the separating wall and slab above. This would be reduced by adding insulation above the slab, and/or increasing the width of the insulation on the separating wall.



**Diagram D4.32**  
Junction below balcony

### SUMMARY OF RECOMMENDATIONS – INTERNALLY INSULATED

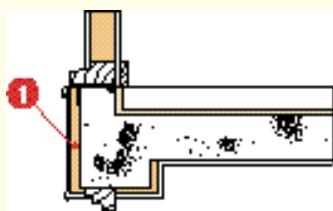
#### A Roof junction



##### Minimum recommendations

- 1 Upgrade roof insulation.
- 2 Add new ceiling incorporating a vapour control layer and perimeter insulation.

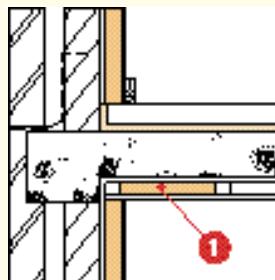
#### B Infill panel junction



##### Minimum recommendations

- 1 Insulate edge of ring beam.

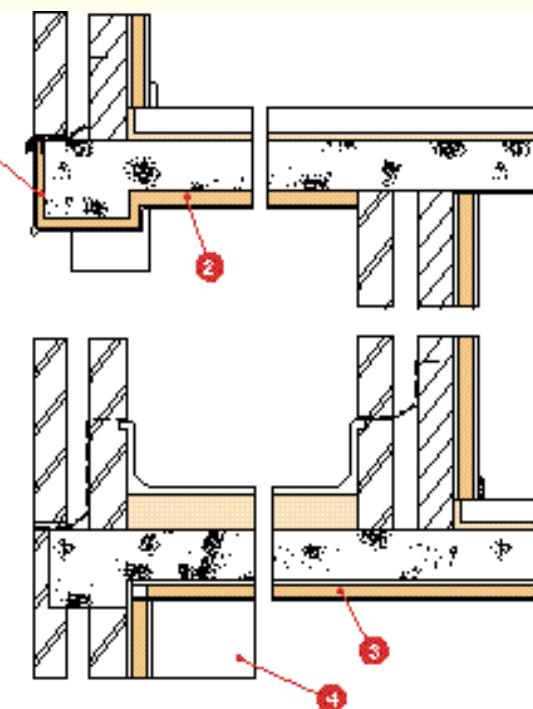
#### C Ring beam junction



##### Best practice

- 1 Add new ceiling incorporating a vapour control layer and perimeter insulation.

#### D Balcony junction



##### Minimum recommendations

- 1 Insulate edge of ring beam.
- 2 Insulate underside of exposed concrete.
- 3 Insulate underside of balcony deck.
- 4 Return insulated dry-lining at least 300 mm at separating walls.

**Note:** Slight risk of mould persists with details D4.31 and D4.32 page 59.

**Note:** Internal insulation should include a vapour check on the warm side of the insulation.

# External insulation added

The examples in this chapter show a typical external wall insulation system comprising 50 mm thick insulation with a 10 mm polymer render finish. The insulant is assumed to be mineral wool with a conductivity of 0.036 W/mK.

The results would be similar if, instead of applying a render finish to the insulation, some form of overcladding was used. However, where overcladding is used, the

supporting metal framework should be designed so that the number of metal fixings passing through the insulation layer is kept to a minimum.

The design and installation of external insulation is a specialist job. An insulation system with an Agrément certificate installed by a specialist installer approved by the certificate holder is strongly recommended.

A

## ROOF JUNCTION - EXTERNALLY INSULATED

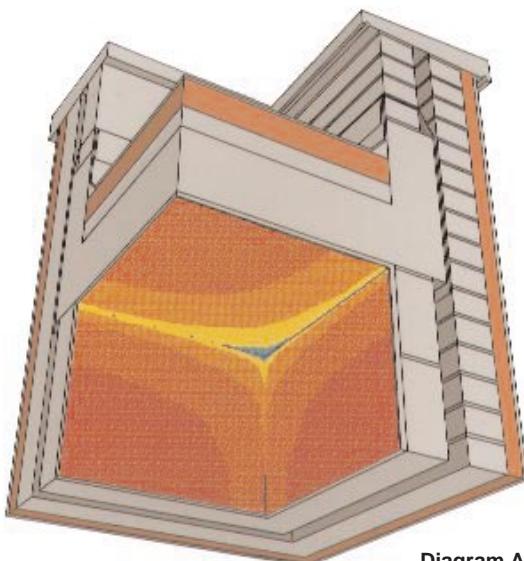


Diagram A4.33

### RISK OF MOULD

With the addition of new roof insulation to achieve a U-value of 0.35 W/m<sup>2</sup>K and external insulation, the wall and ceiling surfaces are significantly warmer, but the thermal bridge through the concrete upstand and parapet wall still results in a risk of mould growth in the corner.

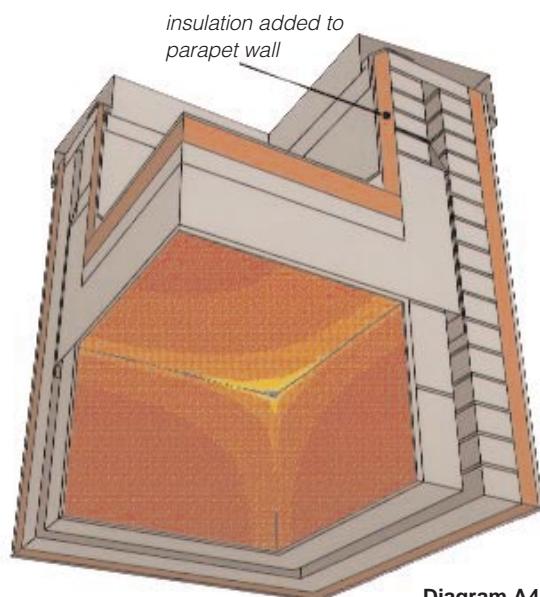


Diagram A4.34

### SLIGHT RISK OF MOULD

Insulating both sides of the parapet wall extends the length of the thermal bridge path, virtually eliminating the risk of mould growth.

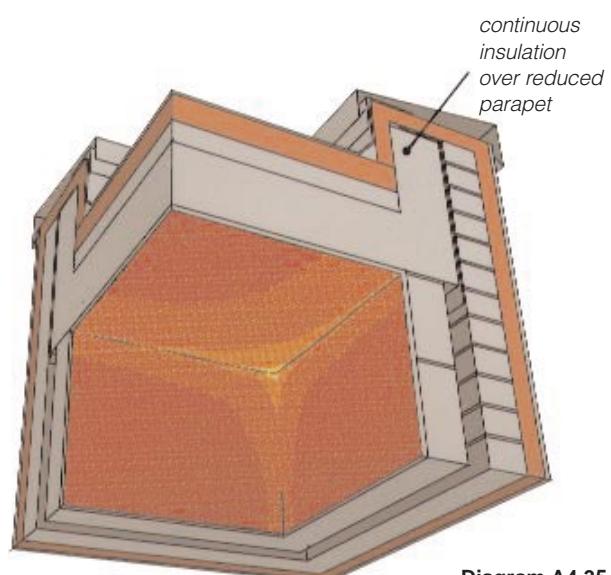


Diagram A4.35

### BEST PRACTICE

The best results are obtained by reducing the height of the parapet wall and providing a continuous external layer of insulation. Despite the continuity of external insulation, the temperature in the corner is 2 to 3°C colder than over the main wall and ceiling areas. This can be attributed to the geometry of the junction.

### B INFILL PANEL JUNCTION – EXTERNALLY INSULATED

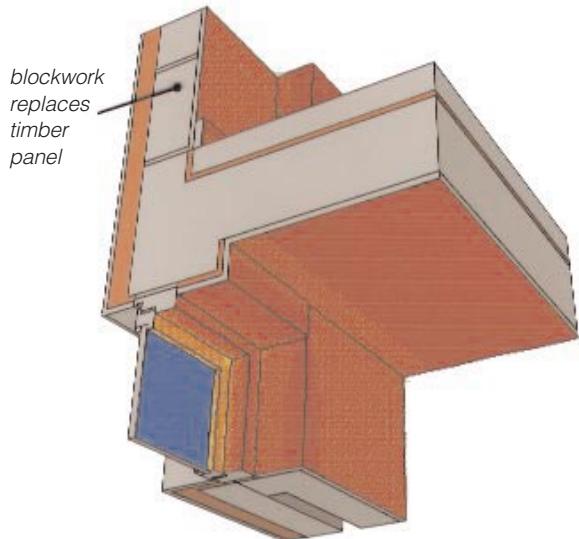


Diagram B4.36  
Viewed from below

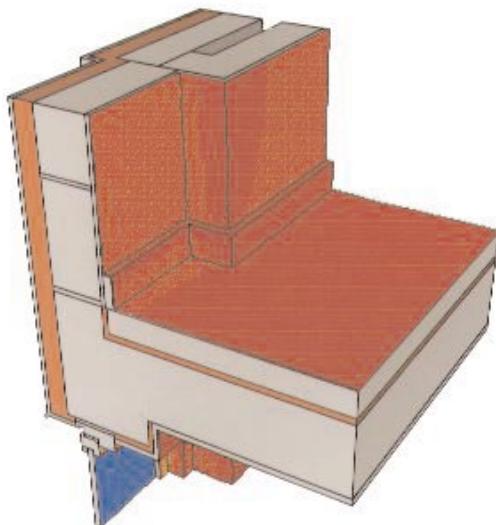


Diagram B4.37  
Viewed from above

#### BEST PRACTICE

In this detail, the timber infill panel is replaced by a skin of blockwork and the whole of the external wall is insulated. A 13 mm thickness of insulation is returned into the soffit and the reveals at the window opening to avoid a thermal bridge.

### C RING BEAM JUNCTION – EXTERNALLY INSULATED

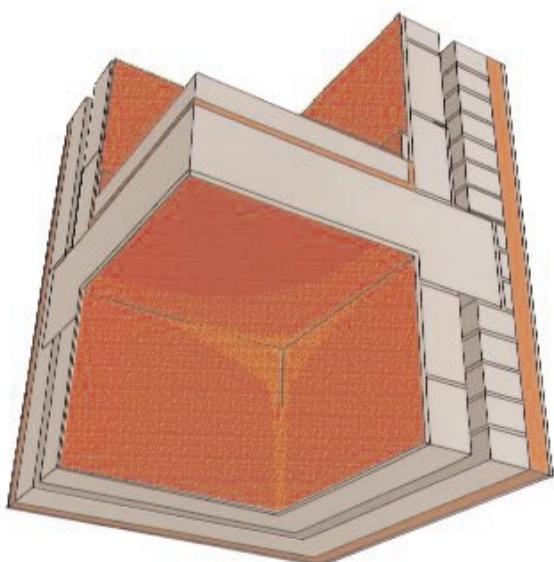


Diagram C4.38

#### BEST PRACTICE

A continuous unbroken layer of insulation at the ring beam is only possible by using external insulation.

The thermal bridge through the downstand beam is eliminated and the high thermal mass on the warm side of the insulation makes the risk of mould growth unlikely.

## D BALCONY JUNCTION – EXTERNALLY INSULATED

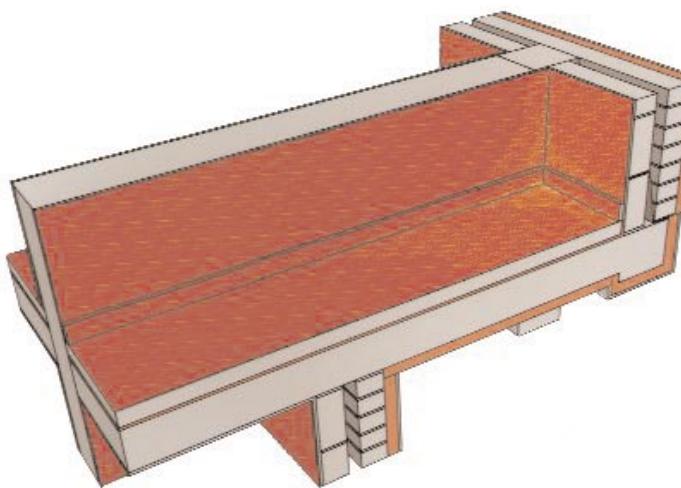


Diagram D4.39  
Junction above balcony

### THERMAL BRIDGE

In Diagram D4.39, the continuity between the external wall insulation and the insulation added to the floor slab and edge beam ensures warm internal surfaces with little risk of mould growth. The small area of orange at the corner of the floor is due to the thermal bridge through the concrete column.

Diagram D4.40 shows how, by combining external insulation and insulation to the balcony slab, surface temperatures are raised sufficiently for there to be little risk of mould growth. However, the concrete edge beam still forms a thermal bridge via the parapet wall. Adding insulation to the inside of the balcony wall would extend the thermal bridge path, but insulation in this position would be vulnerable to damage. The external insulation shown on the inner wall of the balcony would also be vulnerable to damage. For this reason, it would be worth considering cavity wall insulation instead of external insulation for this wall.

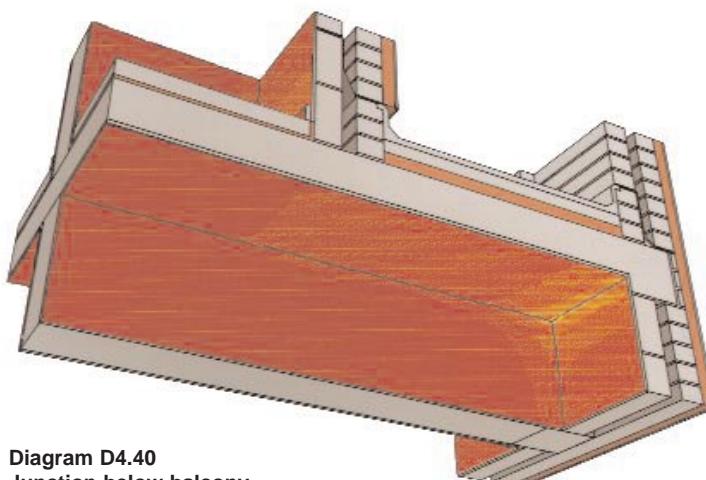
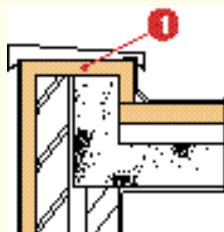


Diagram D4.40  
Junction below balcony

### SUMMARY OF RECOMMENDATIONS – EXTERNALLY INSULATED

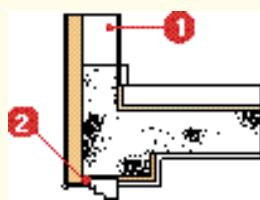
#### A Roof junction



##### Best practice

- 1 Continue external insulation over reduced parapet to link up with roof insulation.

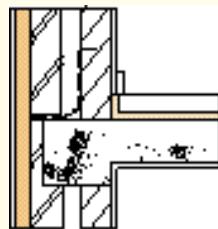
#### B Infill panel junction



##### Best practice

- 1 Replace infill panel with blockwork.
- 2 Return insulation into window openings.

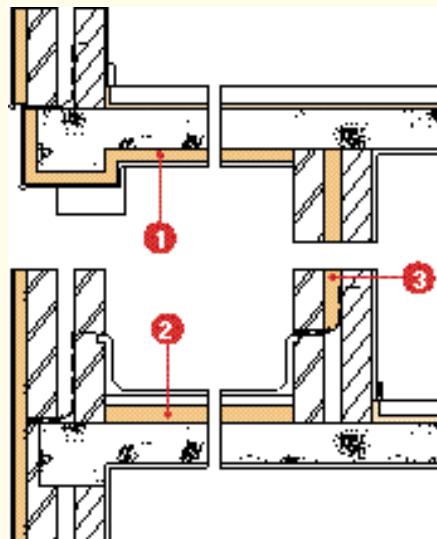
#### C Ring beam junction



##### Best practice

The external wall insulation is continuous.

#### D Balcony junction



##### Minimum recommendations

- 1 External insulation extended to underside of slab.
- 2 Insulation to balcony deck upgraded.
- 3 Cavity insulation is less vulnerable to damage at balcony level.

**Note:** Minimum recommendations provide guidance on reducing the risk of mould growth.

# No-fines concrete

There are about 450 000 dwellings in the UK constructed of no-fines concrete. Most of these are of low rise construction and were built between 1950 and 1980.

The walls of no-fines construction were cast in-situ using only cement and aggregate (between 9 mm and 19 mm in size), ie without sand. The concrete was poured into large moulds, typically two storeys high.

Originally, windows were fixed separately, but later frames or sub-frames were fixed inside the shuttering and the concrete cast with the frames in their final position.

Lintels over window and door openings are usually of dense precast concrete. The no-fines wall is topped with an in-situ dense concrete eaves beam which helps to distribute the loads from the roof. Both these areas of dense concrete form thermal bridges through the wall.

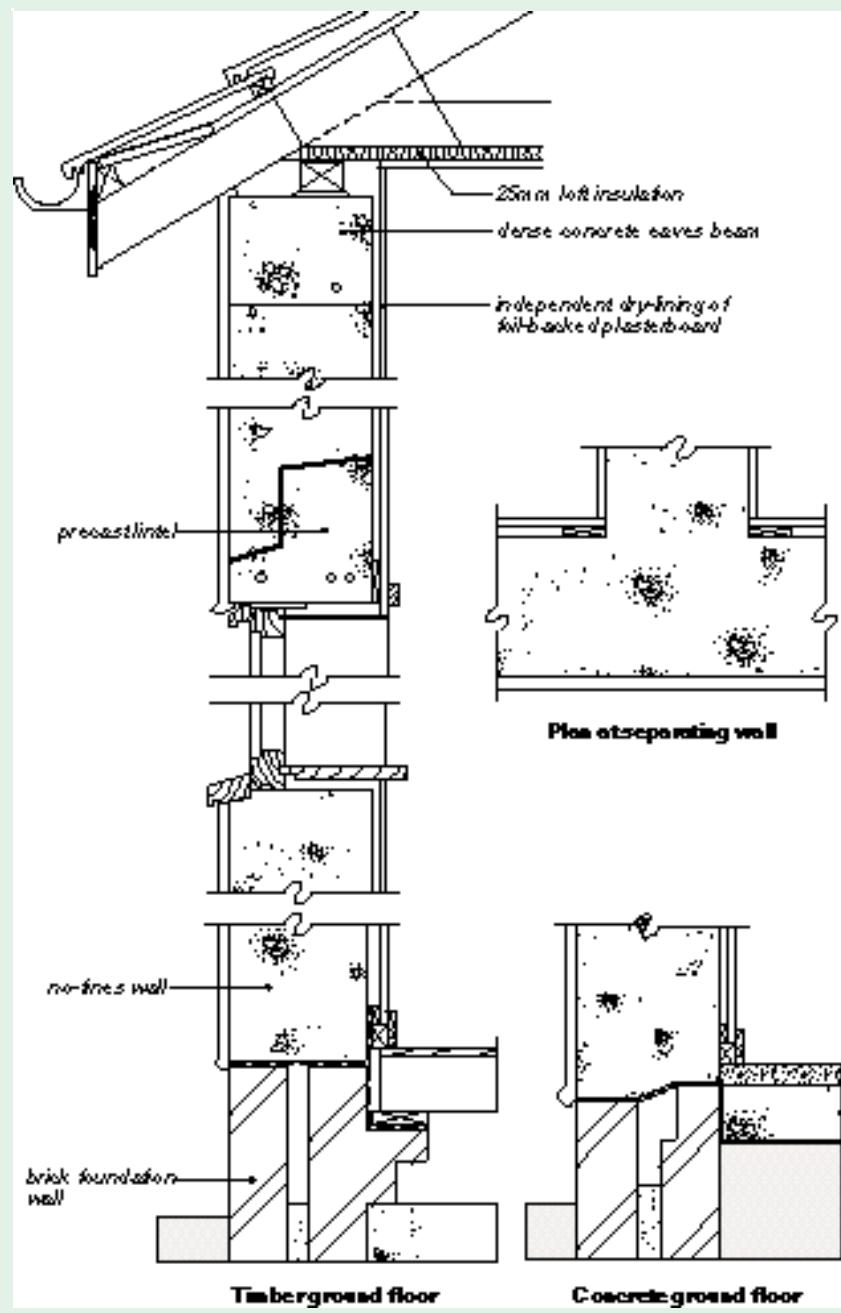
The U-value of the wall construction varies with the thickness of the no-fines wall and the internal finish that was specified. A 250 mm thick wall with a wet plaster finish would have a U-value of about 1.7 W/m<sup>2</sup>K, similar to a brick/cavity/brick wall.

A 200 mm thick wall with an independent cellular-cored plasterboard lining achieves a U-value of about 1.1 W/m<sup>2</sup>K. The 250 mm thick no-fines wall construction on the right has a U-value of about 1.23 W/m<sup>2</sup>K.

The construction details evolved over the years to reflect the changes in legislation and codes of practice. The details shown are typical of those used for low rise construction in the 1960s, with a pitched roof and 25 mm of mineral wool loft insulation above a foil backed plasterboard ceiling. Loft insulation was introduced from the mid 1960s. Flat roofs were also common, particularly for blocks of flats; ground floors were of both solid concrete and suspended timber construction.

The following two pages show the thermal analysis of the existing construction. The remaining pages in this chapter show the effect of adding insulated dry-lining and external insulation.

## CONSTRUCTION DETAILS



# Uninsulated construction

**A****EAVES JUNCTION**

Mineral wool loft insulation 25 mm thick is normally enough to keep the surface temperatures of the ceiling high enough to avoid mould growth. The main thermal bridge at the eaves is through the dense concrete ring beam, but its effect is partially mitigated by the use of the foil-backed plasterboard.

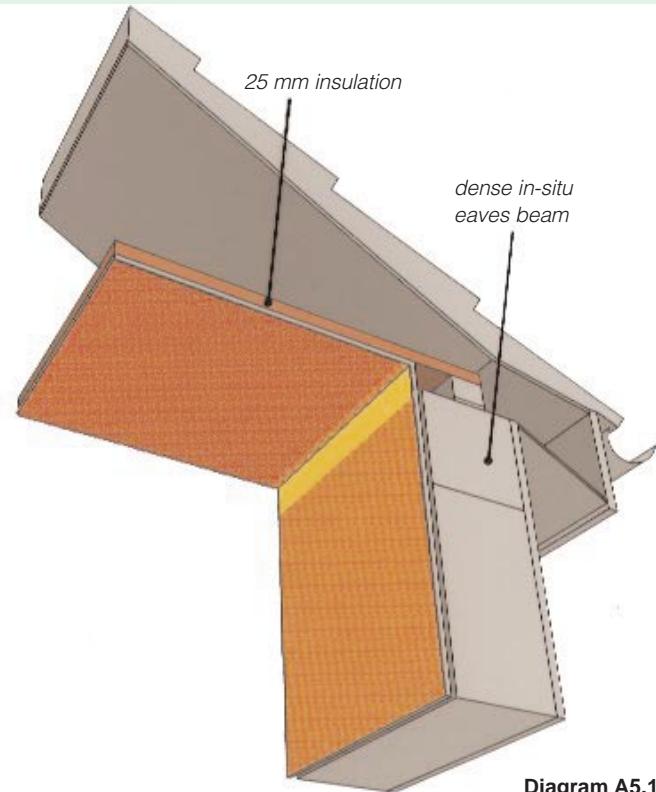


Diagram A5.1

**B****LINTEL JUNCTION****B**

The dense concrete lintel creates a thermal bridge but, as at the eaves detail, the foil-backed plasterboard lining helps to keep the surface temperature of the wall at the lintel above the critical 13.5°C. The coldest surface temperature and hence the greatest risk of mould growth occurs at the junction of the reveal or soffit with the window frame.

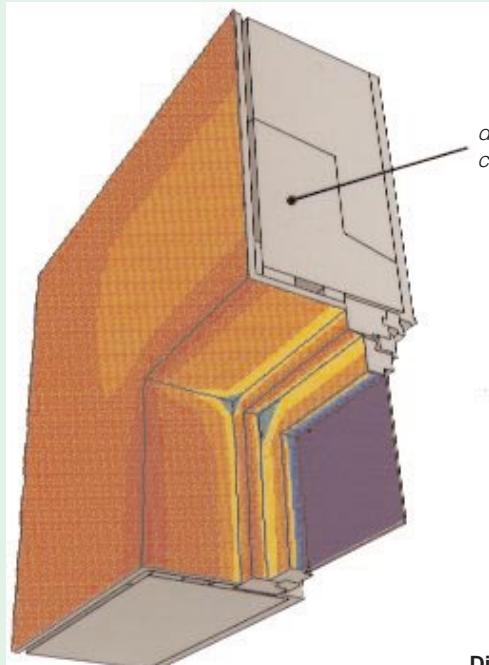


Diagram B5.2

**C****TIMBER GROUND FLOOR JUNCTION**

The lowest temperatures occur at the perimeter of the floor, and just above the skirting level in the corner of the room.

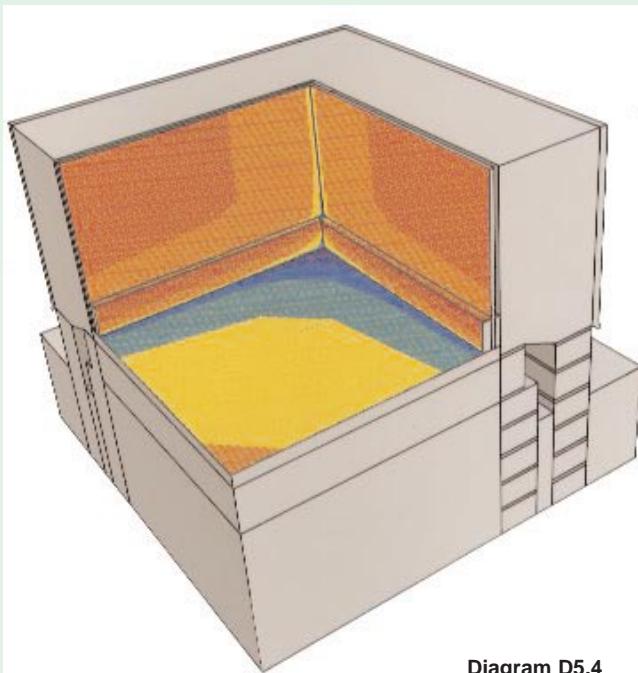


Diagram D5.4

**E****SEPARATING WALL JUNCTION**

The thermal bridge at the perimeter of the floor is less serious at the separating wall than at an external corner, but still presents a risk of mould growth. A second, less serious thermal bridge through the separating wall is at the junction with the external wall.

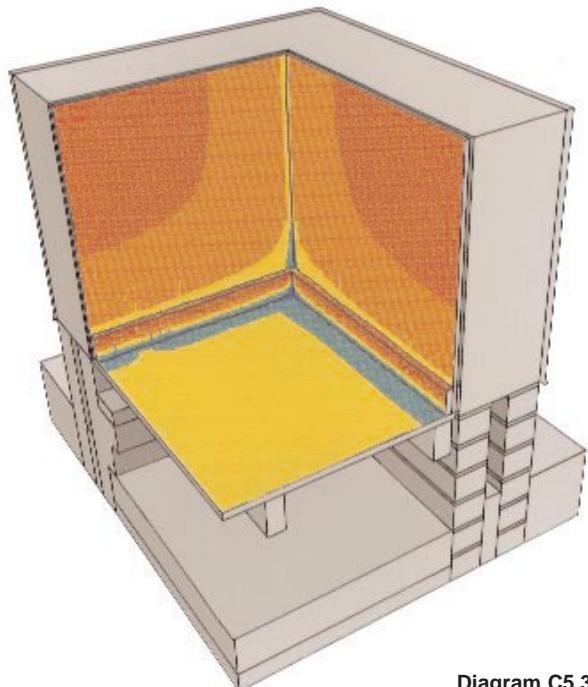


Diagram C5.3

**CONCRETE GROUND FLOOR JUNCTION**

This detail clearly shows that the most serious thermal bridge is at the perimeter of the floor, where there is a high risk that mould growth will occur. The risk of mould growth is much more severe with a concrete floor than with a suspended timber floor.

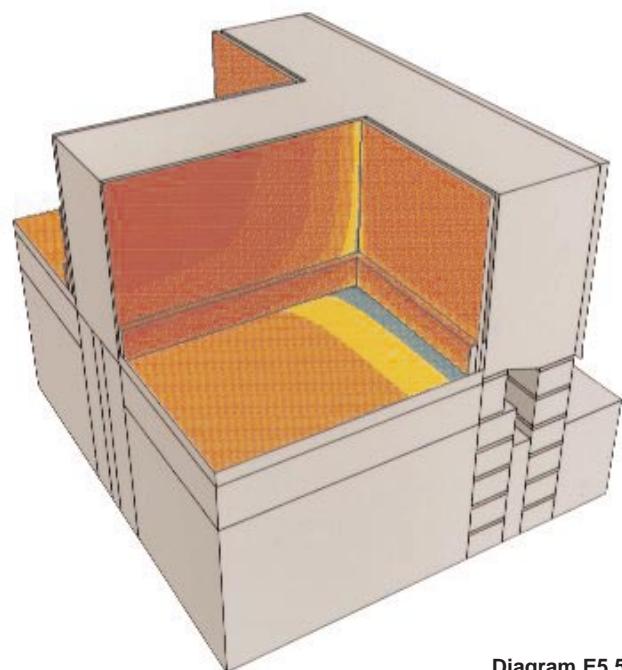


Diagram E5.5

## Internal insulation added

The examples in this section show a 50 mm thick insulated dry-lining, adhesive fixed to the existing plasterboard lining. The insulant has a conductivity of 0.027 W/mK. This improves the U-value of the existing wall from about 1.23 W/m<sup>2</sup>K to about 0.44 W/m<sup>2</sup>K.

Insulated dry-lining can also be added to walls with a wet plaster finish or an independent cellular-cored plasterboard lining, provided the existing walls do not suffer from rain penetration. Where walls do suffer from rain penetration, external wall insulation is recommended. Internal insulation should include a vapour check on the warm side of the insulation

### **A EAVES JUNCTION – INTERNALLY INSULATED**

#### **BEST PRACTICE**

A combination of 150 mm loft insulation and an insulated dry-lining minimises the thermal bridge at eaves level.

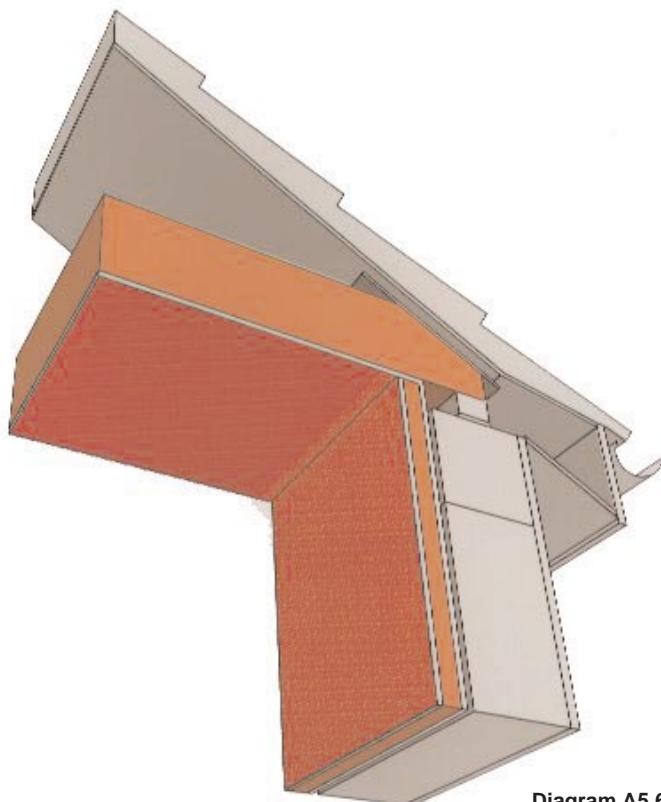


Diagram A5.6

## B LINTEL DETAIL – INTERNALLY INSULATED

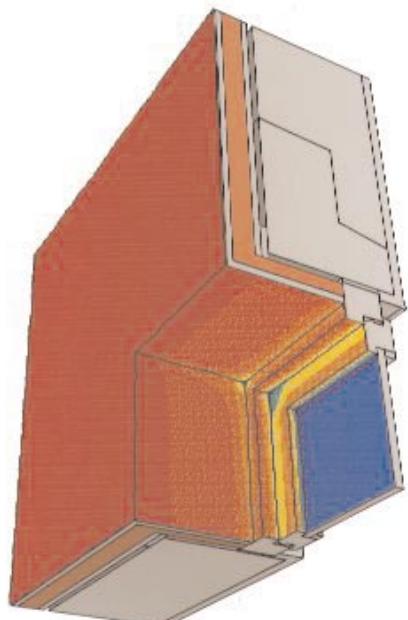


Diagram B5.7

### BEST PRACTICE

Where dry-lining is used, it must be returned into the reveals and soffit of window and door openings. In most cases a thinner dry-lining has to be used at the reveals and soffits to avoid masking the window frame. In this detail, the existing plasterboard to the reveals and soffit has been removed in order to accommodate a dry-lining board with 20 mm of insulation in conjunction with a replacement double glazed window.

## C TIMBER GROUND FLOOR JUNCTION – INTERNALLY INSULATED

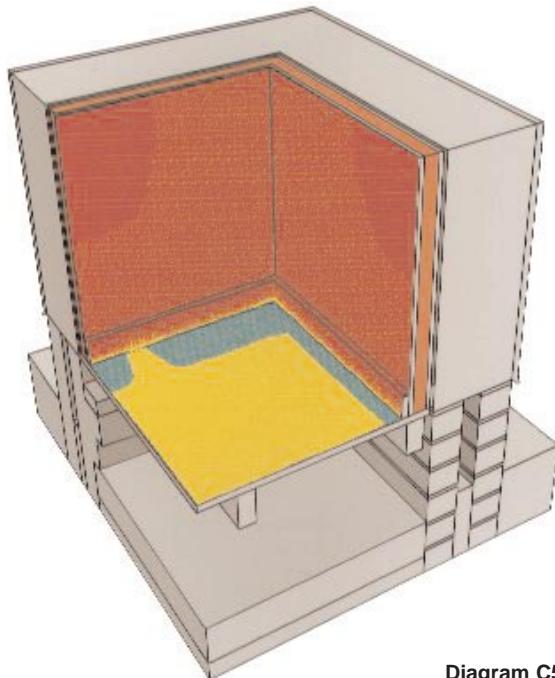


Diagram C5.8

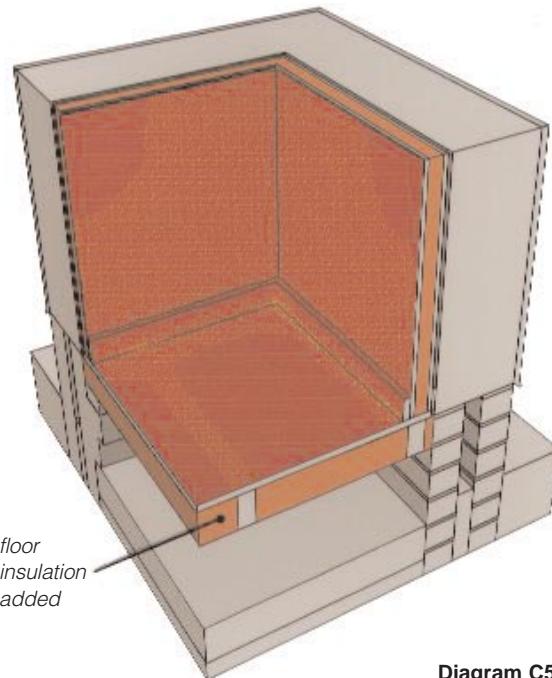


Diagram C5.9

### RISK OF MOULD

The use of insulated dry-lining avoids any hint of a thermal bridge at the external corner. Low surface temperatures persist through the uninsulated floor.

### BEST PRACTICE

Adding 100 mm of mineral wool between the floor joists avoids thermal bridging and raises the surface temperature of the floor to that of the wall.

### D CONCRETE GROUND FLOOR JUNCTION – INTERNALLY INSULATED

#### MAJOR RISK OF MOULD

As with the timber floor, insulating the walls only serves to accentuate the severe thermal bridge at the perimeter of the floor. The insulated dry-lining has the effect of making the no-fines concrete wall colder, exacerbating the thermal bridge at the wall/floor junction.

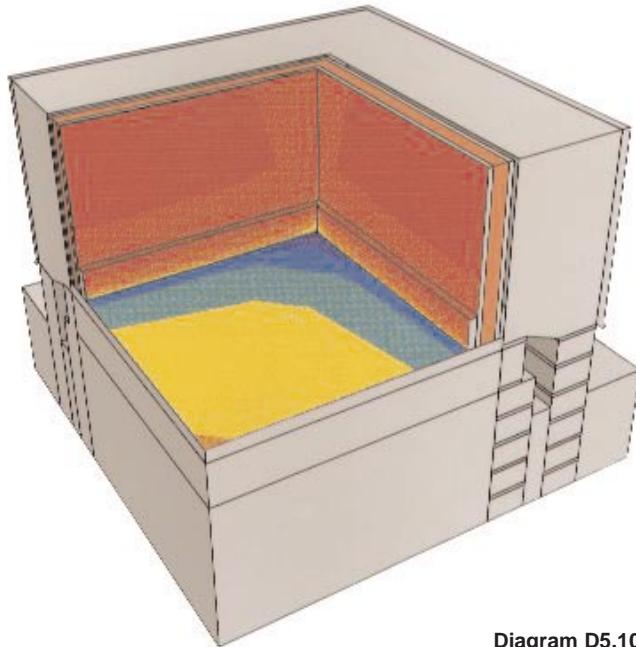


Diagram D5.10

#### BEST PRACTICE

By laying 25 mm of insulation and 18 mm chipboard on the concrete floor, its surface temperature is raised to that of the wall. However, raising the floor level in this way makes it necessary to shorten internal doors and can present problems at the junction with the staircase. Adding floor insulation is not a practical option unless the properties are decanted.

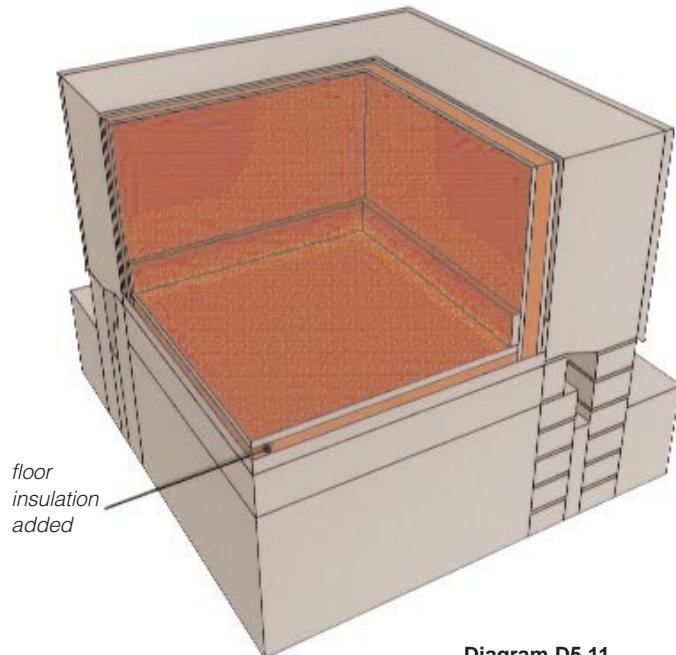


Diagram D5.11

## E

**SEPARATING WALL JUNCTION – INTERNALLY INSULATED****SLIGHT RISK OF MOULD** ➔

When the external wall and ground floor are insulated, the junction between the separating wall and the external wall presents the most serious thermal bridge and there is a risk of mould growth occurring.

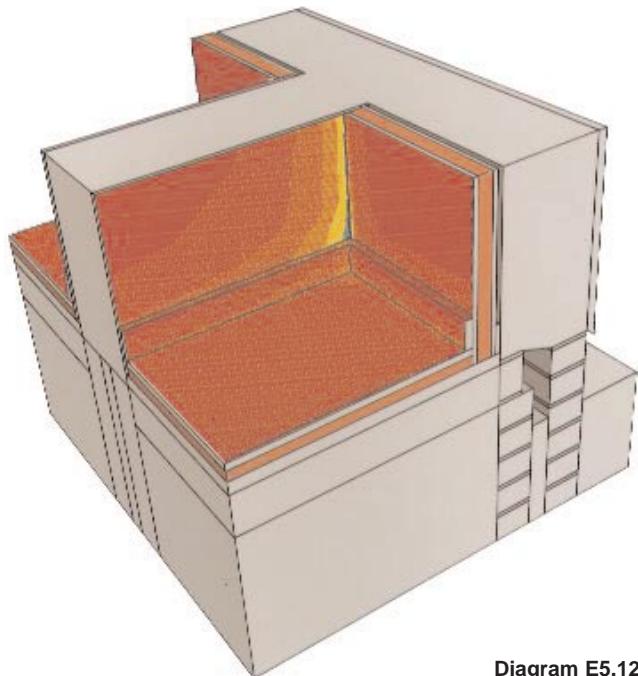


Diagram E5.12

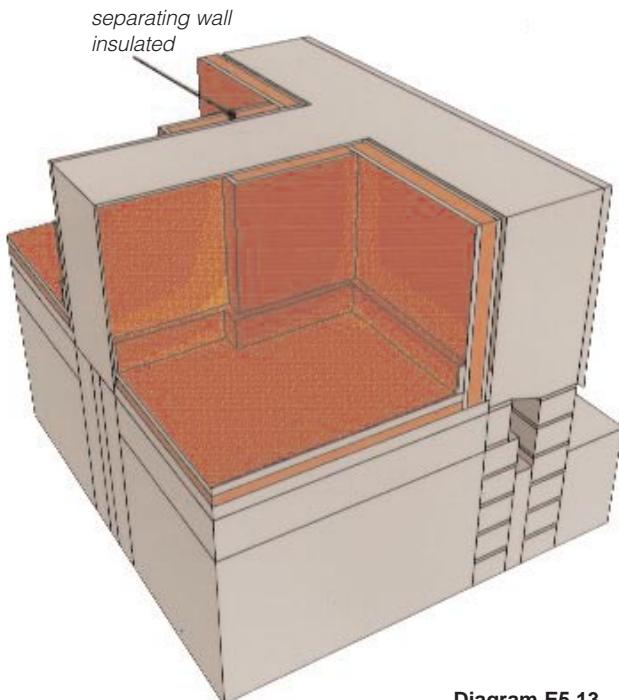


Diagram E5.13

**BEST PRACTICE** ➜

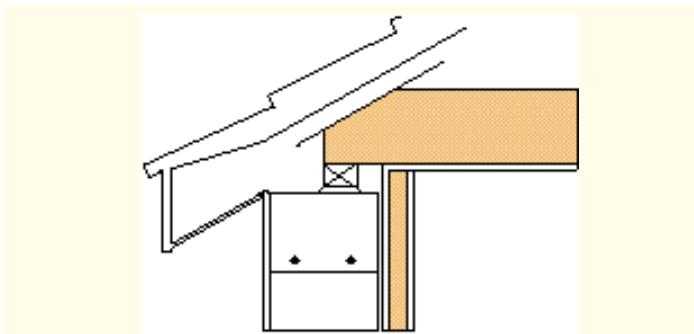
This detail shows the effect of returning a 1000 mm wide strip of dry-lining each side of the separating wall. The thermal bridge is greatly reduced, and there is little risk of mould growth occurring.

### SUMMARY OF RECOMMENDATIONS – INTERNAL INSULATION

#### A Eaves junction

##### Best practice

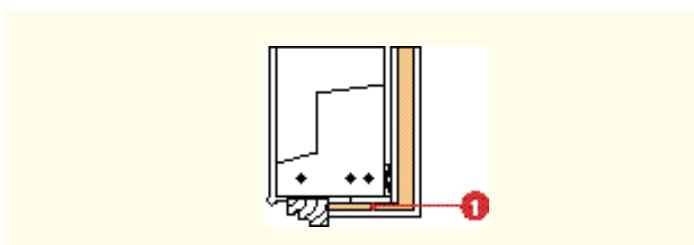
The internal wall and roof insulation are continuous.



#### B Lintel junction

##### Best practice

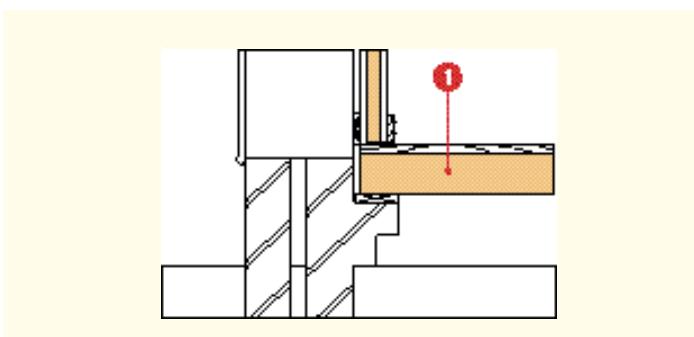
1 Return the insulated dry-lining into the soffit and reveals.



#### C Timber ground floor junction

##### Best practice

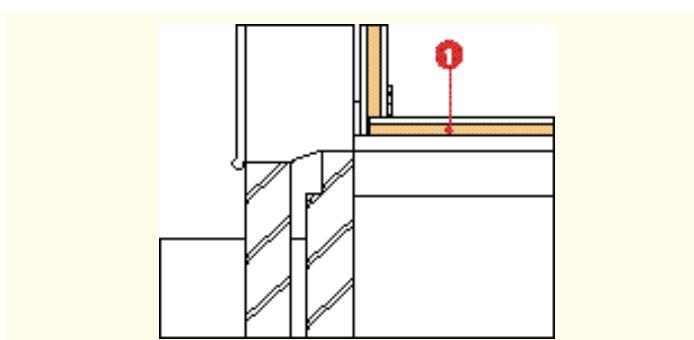
1 Specify floor insulation as well as dry-lining to avoid thermal bridging.



#### D Concrete ground floor junction

##### Best practice

1 Specify floor insulation as well as dry-lining to avoid thermal bridging.

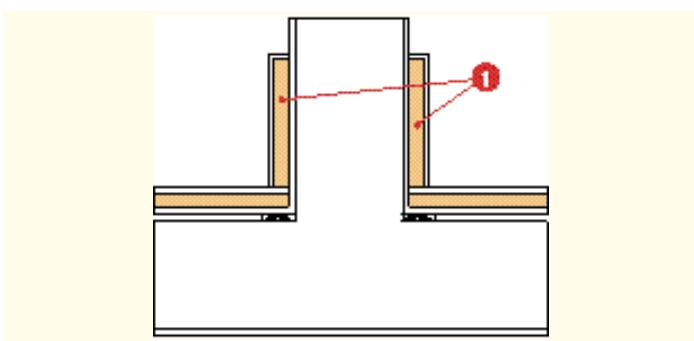


#### E Separating wall junction

##### Best practice

1 Return the dry-lining at least 1000 mm along both sides of the separating wall (not shown to scale).

**Note:** Consideration should be given to the aesthetics of this detail. It may be preferable to cover the whole of the internal wall or stop the insulation at an acceptable point depending on room layout.



**Note:** Internal insulation should include a vapour check on the warm side of the insulation.

# External insulation added

The examples in this section show an external wall insulation system comprising 50 mm thick insulation with a 10 mm polymer render finish. The insulant is assumed to be mineral wool with a conductivity of 0.036 W/mK. This improves the U-value of the existing wall from about 1.23 W/m<sup>2</sup>K to about 0.45 W/m<sup>2</sup>K.

A

## EAVES JUNCTION – EXTERNALLY INSULATED

### THERMAL BRIDGE

Adding 150 mm loft insulation and external wall insulation greatly reduces the effect of the thermal bridge through the dense concrete edge beam. However, the lack of continuity between the loft and wall insulation still leaves a thermal bridge.

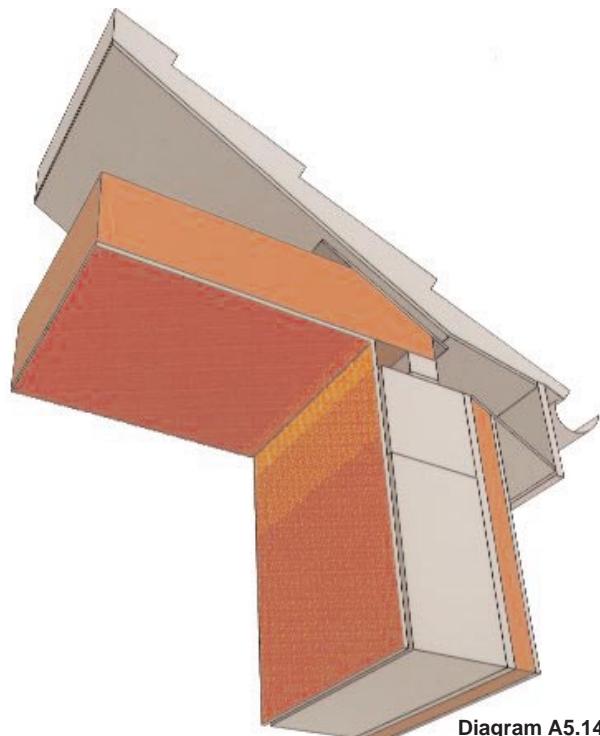


Diagram A5.14

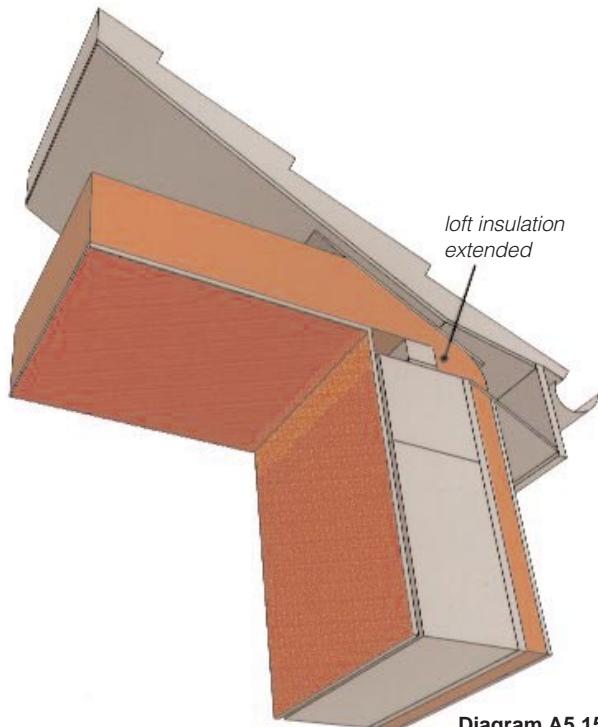


Diagram A5.15

### BEST PRACTICE

Continuity between loft and external wall insulation will only be possible if the first few rows of roof tiles at the eaves are removed.

### B LINTEL DETAIL – EXTERNALLY INSULATED

#### BEST PRACTICE

There is no thermal bridge where the external wall insulation is detailed to abut the window frame. In this case, a replacement double glazed window is shown.

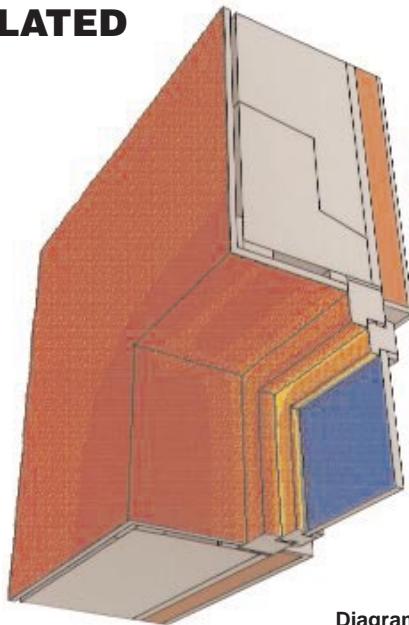


Diagram B5.16

### C TIMBER GROUND FLOOR JUNCTION – EXTERNALLY INSULATED

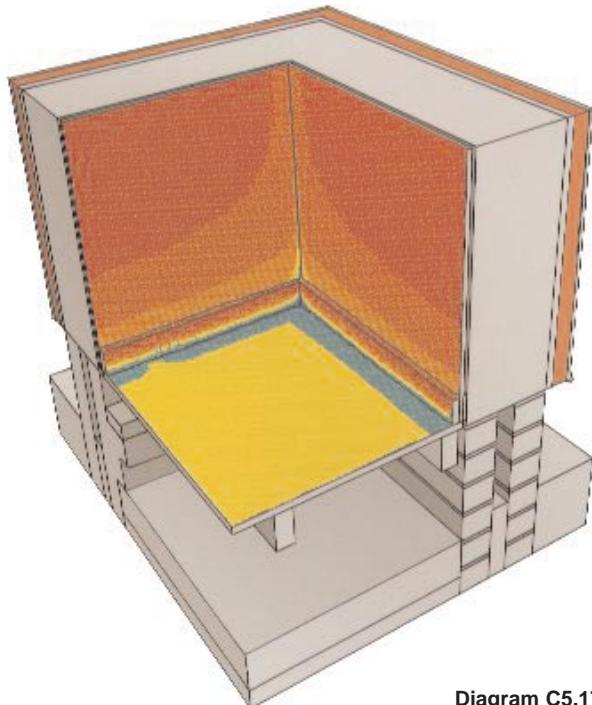


Diagram C5.17

#### RISK OF MOULD

Diagram C5.17 shows the external wall insulation stopping at the base of the no-fines wall. Although there is a thermal bridge through the wall just above skirting level, the lowest surface temperatures are at the perimeter of the floor.

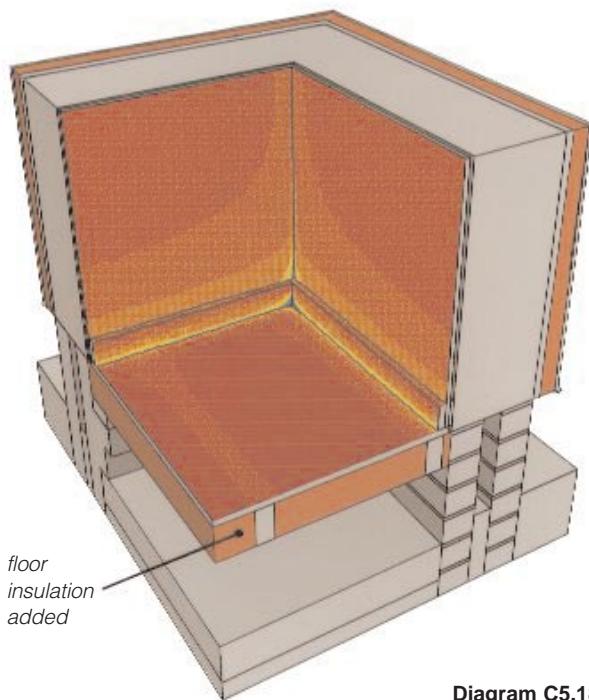


Diagram C5.18

#### SLIGHT RISK OF MOULD

Adding insulation between the floor joists raises the surface temperature of the floor substantially. The thermal bridge at the perimeter of the floor is virtually eliminated. The thermal bridge through the wall, however, is unaffected. Even extending the external wall insulation below dpc level does not avoid the thermal bridge since the main heat loss path is through the inner leaf of the brick foundation wall.

## D CONCRETE GROUND FLOOR JUNCTION – EXTERNALLY INSULATED

### MAJOR RISK OF MOULD

Diagram D5.19 shows the external wall insulation stopping at the base of the no-fines wall. The external insulation not only raises the surface temperature of the wall, but also reduces the severity of the thermal bridge at the perimeter of the floor.

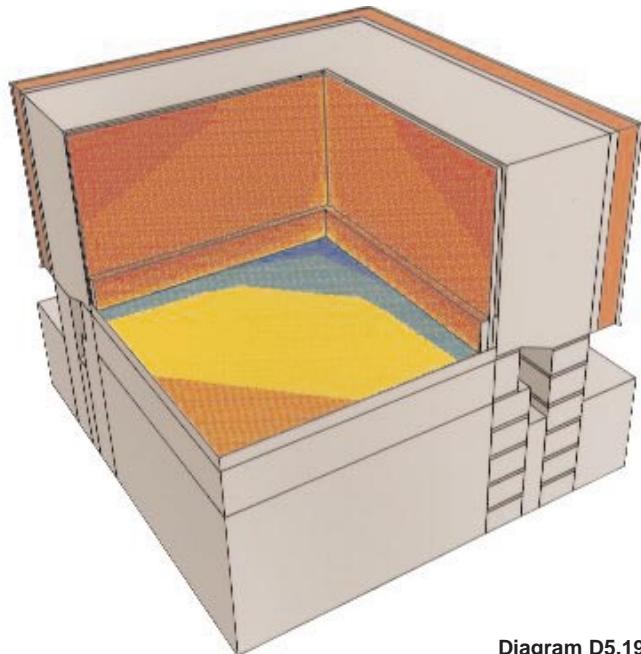


Diagram D5.19

### SLIGHT RISK OF MOULD

Extending the external wall insulation to the face of the brickwork further reduces the severity of the thermal bridge at the floor perimeter. The combination of perimeter insulation and external wall insulation is very effective at reducing the risk of mould growth at the perimeter of concrete ground floors.

perimeter  
insulation  
added

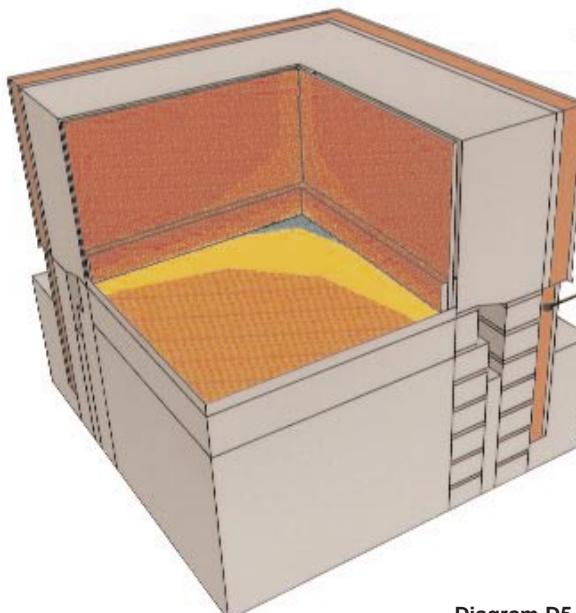
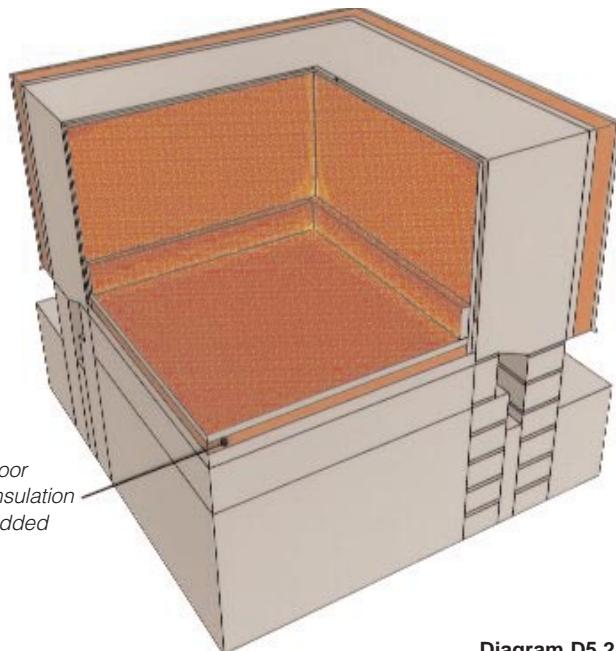
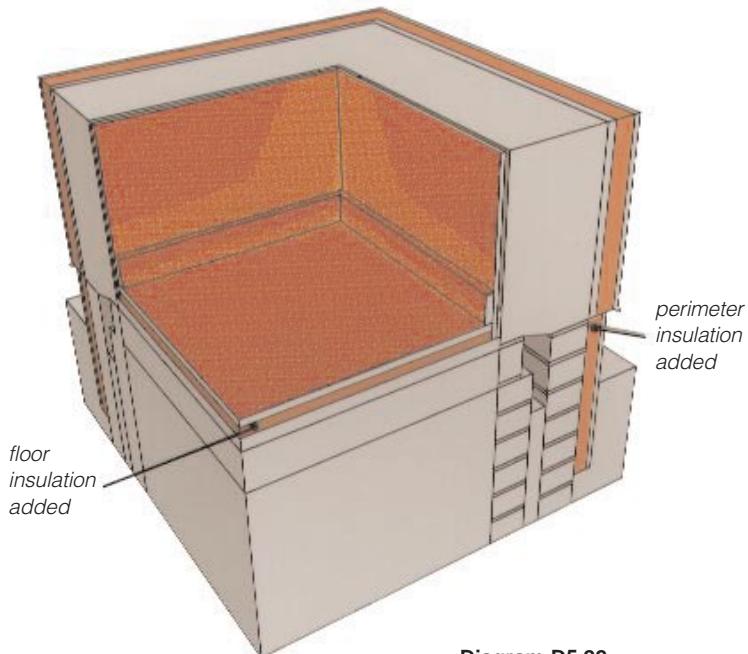


Diagram D5.20

**D CONCRETE GROUND FLOOR JUNCTION – EXTERNALLY INSULATED**  
***continued*****MINOR THERMAL BRIDGE**

Adding 25 mm of expanded polystyrene with a chipboard finish results in a much warmer floor surface than with perimeter insulation. However, unless the properties are being decanted this will not be a practical option. It also requires internal doors to be shortened and presents a problem at the staircase.

**Diagram D5.21****BEST PRACTICE**

The combination of ground floor insulation and perimeter insulation gives the best results for an externally insulated wall.

**Diagram D5.22**

## E

**SEPARATING WALL JUNCTION – EXTERNALLY INSULATED****SLIGHT RISK OF MOULD** →

Diagram E5.23 shows the external wall insulation stopping at the base of the no-fines wall. The thermal bridge at the perimeter of the floor is less at risk from mould growth than at the external corner.

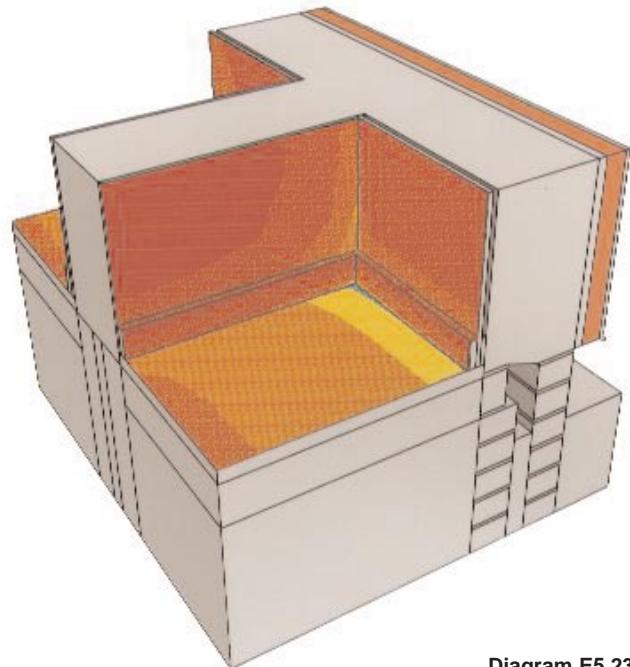


Diagram E5.23

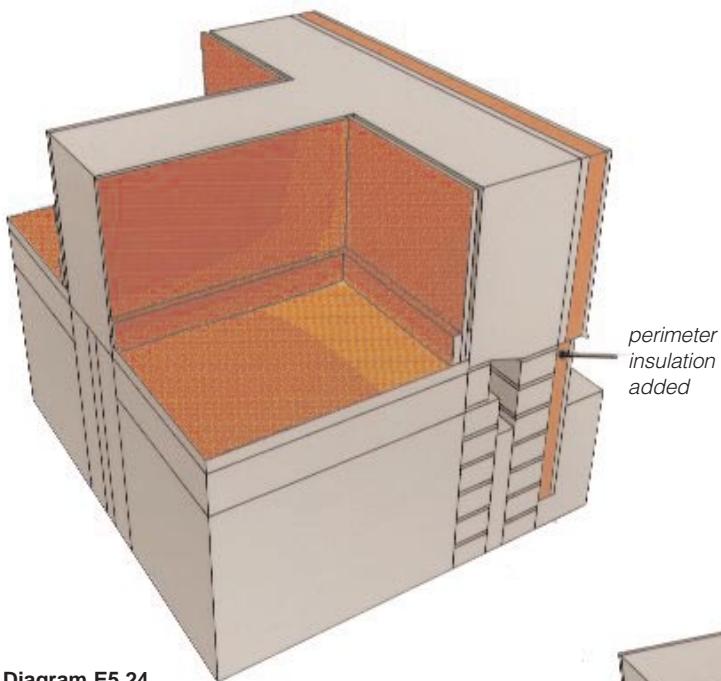
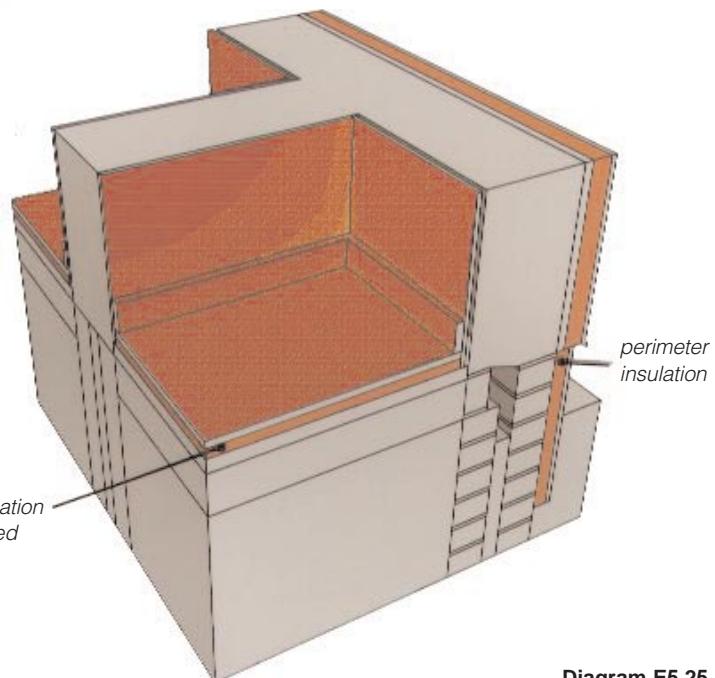


Diagram E5.24

**THERMAL BRIDGE**

Extending the external wall insulation to the face of the brickwork reduces the thermal bridge at the floor perimeter. The internal surfaces at the junction of the separating wall and the external wall are also warmer as a result of the perimeter insulation.

**BEST PRACTICE** →

The surface temperature of the floor is higher when insulation is added above the floor than when perimeter insulation is used alone, but the temperature of the separating wall is lower at the junction with the external wall.

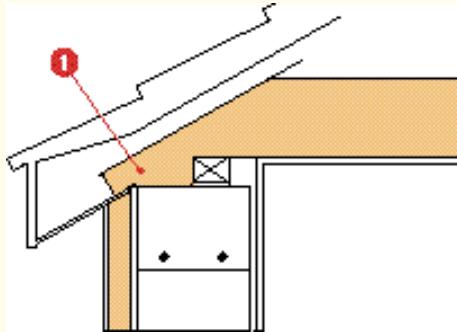
Diagram E5.25

### SUMMARY OF RECOMMENDATIONS – EXTERNAL INSULATION

#### A Eaves junction

##### Best practice

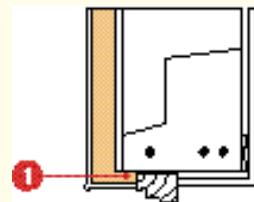
- 1 Take the roof insulation over the wall plate to provide continuity with the wall insulation.



#### B Lintel junction

##### Best practice

- 1 Return the external insulation into the window openings.

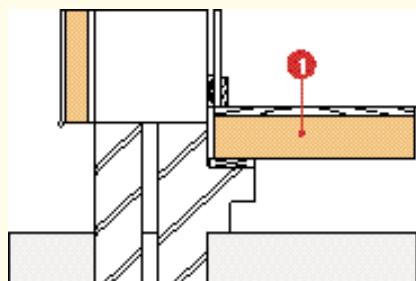


#### C Timber ground floor junction

##### Minimum recommendations

- 1 Specify floor insulation to minimise thermal bridging.

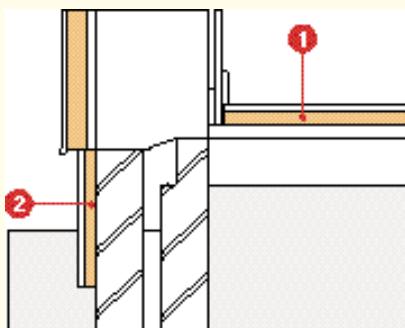
**Note:** Slight risk of mould persists with detail C5.18, page 74.



#### D Concrete ground floor junction

##### Best practice

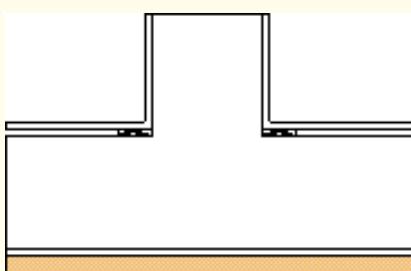
- 1 Specify floor insulation.
- 2 Add perimeter insulation below dpc level.



#### E Separating wall junction

##### Best practice

The external wall insulation is continuous, avoiding thermal bridging at the separating wall.



# Large panel systems

Several large panel concrete systems (LPS) were developed in the 1960s and early 1970s to supply a rapidly increased demand for public housing. The construction of the panels and the junction details varied from one system to another, but there were several features that were common to all.

- The structural precast concrete wall panels were storey height.
- The floors were also constructed of precast concrete panels which were generally room sized.
- Wall insulation (usually expanded polystyrene) was either sandwiched between two layers of concrete or added as part of an internal dry-lining system.
- In-situ concrete was used at panel junctions to ensure continuity of the reinforcement. To minimise thermal bridging, strips of expanded polystyrene were positioned in the joints before the in-situ concrete was placed.

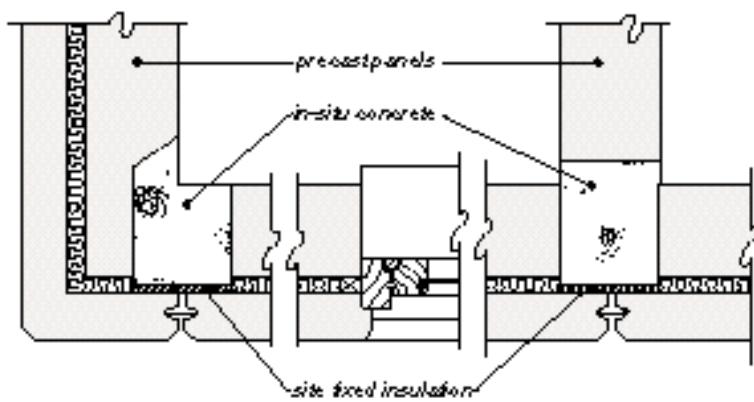
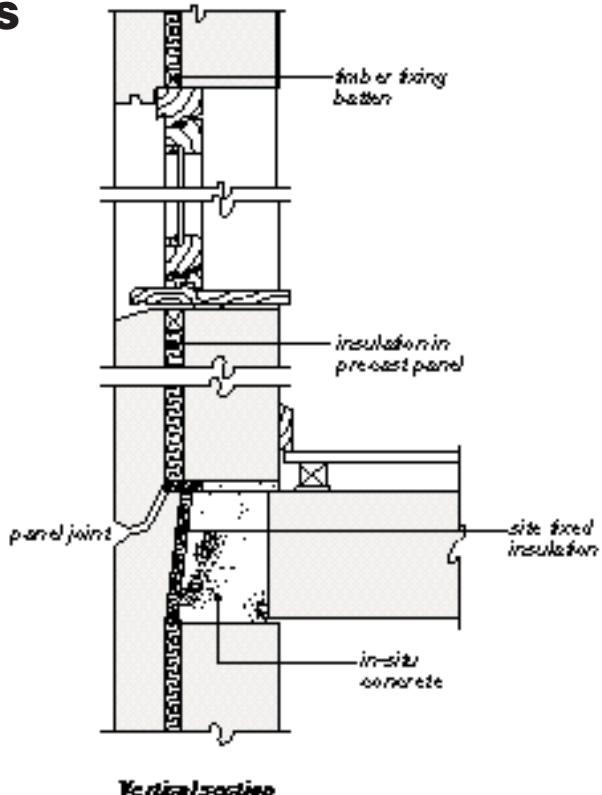
The construction details shown here for the Bison Wall Frame system are typical of large panel construction during the system building boom in the 1960s and 1970s.

Although the calculated U-values for the panels are usually slightly better than for contemporary traditional brick cavity construction, several factors have combined to give LPS a poor performance record compared with traditional construction. These factors are:

- the higher exposure of multi-storey blocks (using LPS) compared with two storey housing
- rain penetration through the joints between panels
- the high thermal capacity of the dense structural concrete, making it susceptible to condensation when heating is intermittent
- the inability of the dense concrete to temporarily absorb moisture and release it when the dwelling is heated.

The following two pages show the thermal analysis of the existing construction. The remaining pages in this chapter show the effect of adding an insulated dry-lining and external insulation.

## CONSTRUCTION DETAILS



# Uninsulated construction

**A**

### UPPER FLOOR JUNCTION

The reduced thickness of wall insulation at panel junctions increases the severity of the thermal bridge at the corner. If, in addition, the strip of site-fixed expanded polystyrene insulation was dislodged when the concrete was placed in the panel joints, there would be a thermal bridge and a high risk of mould growth at the corner, see opposite page.

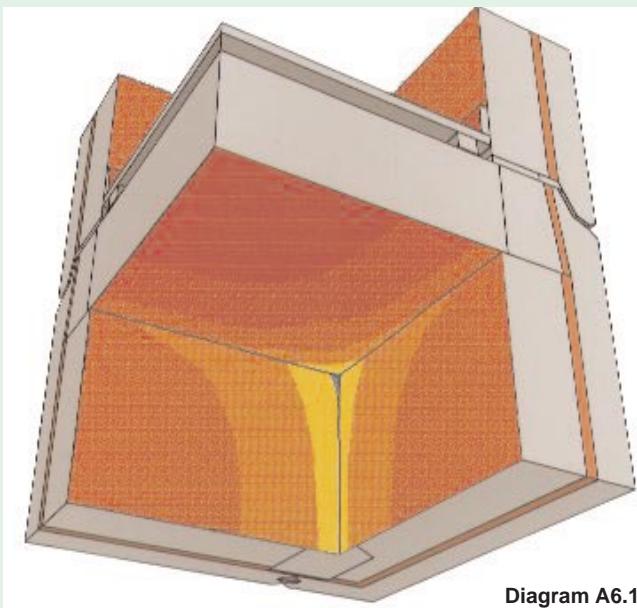


Diagram A6.1

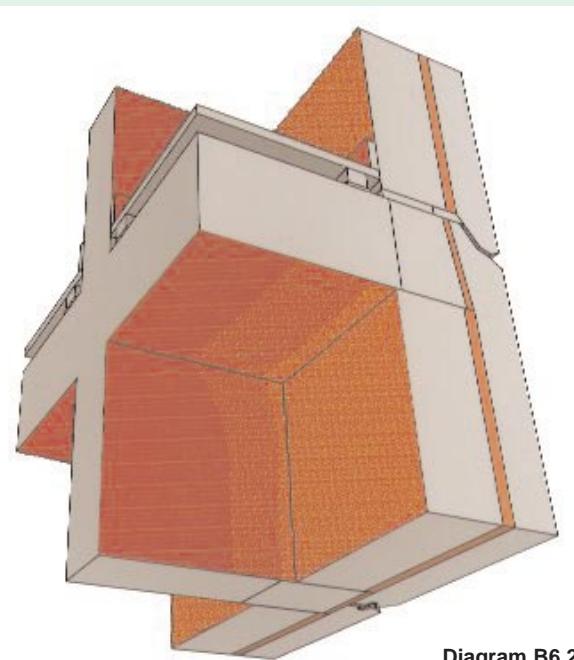


Diagram B6.2

### SEPARATING WALL JUNCTION

**B**

The continuous layer of wall insulation prevents a thermal bridge. However, if the site-fixed insulation was omitted or dislodged during concreting a serious thermal bridge would be created, see opposite page.

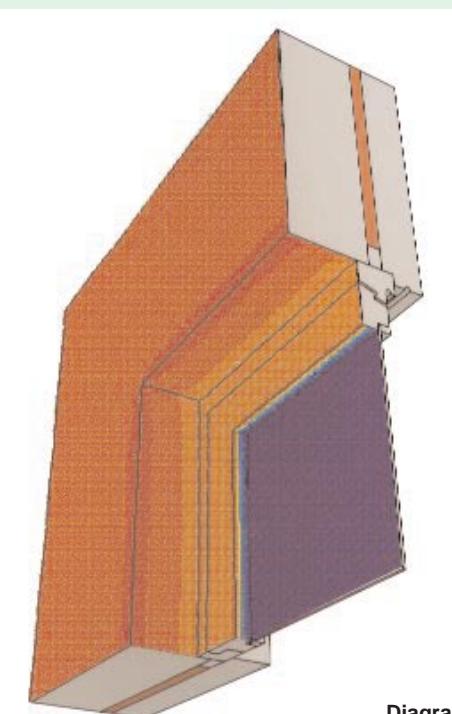


Diagram C6.3

**C**

### WINDOW JUNCTION

The fact that the panel insulation and the glazing are in the same plane helps to avoid a serious thermal bridge. Where the insulation is damaged or the timber fixing batten is bridged by concrete, mould growth can be expected at the jamb and/or soffit.

# Uninsulated construction (assuming site placed insulation was omitted)

B

## SEPARATING WALL JUNCTION

In practice, many schemes constructed from storey height concrete panels suffer from mould in the corner of rooms. The thermograph below shows surface temperatures at a junction where mould growth was a problem.

In many LPS it is necessary to place the insulation at panel junctions on site. Diagrams B6.4 and B6.5 illustrate the seriousness of the thermal bridge if this insulation is omitted or dislodged. The thermal analysis shows surface temperatures very similar to those in the thermograph.

This is a thermograph showing the same detail as Diagram B6.4. Surface temperatures are lower and there is a window in the bottom left hand corner.

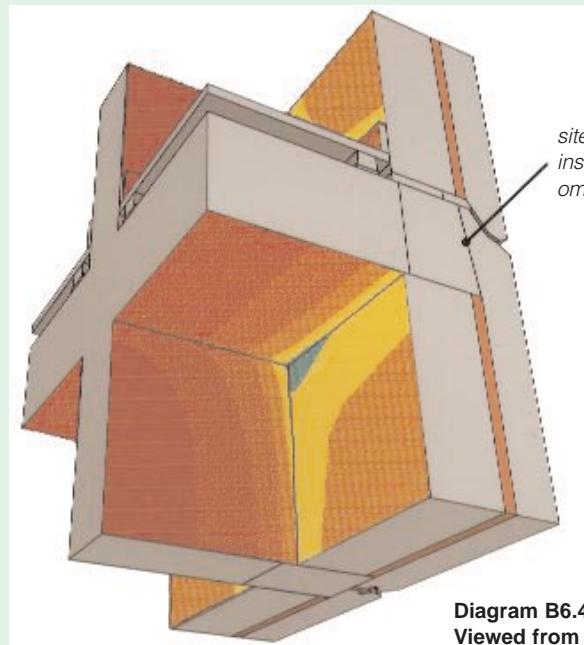
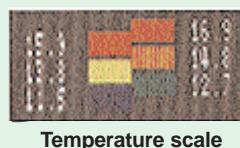


Diagram B6.4  
Viewed from below

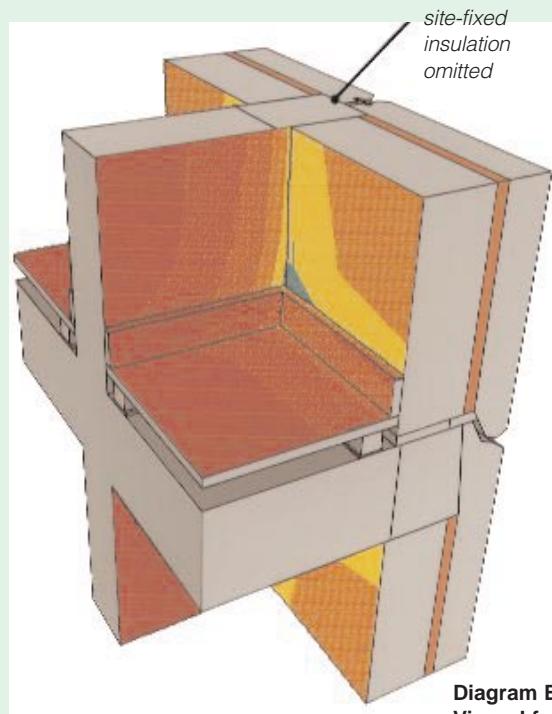


Diagram B6.5  
Viewed from above

# Internal insulation added

The examples in this section show a 50 mm thick insulated dry-lining, adhesive fixed to the existing concrete panel. The insulant has a conductivity of 0.027 W/mK. This improves the U-value of the existing wall construction from about 1.0 W/m<sup>2</sup>K to about 0.4 W/m<sup>2</sup>K.

The dense concrete panels are often difficult to drill for the mechanical fixings needed to secure the insulation backed plasterboard dry-lining in place. It is essential that dry-lining

should not be used where there is a risk of rain penetration through the panels or joints. In such cases, external wall insulation is recommended. Internal insulation should include a vapour check on the warm side of the insulation.

## A EAVES JUNCTION – INTERNALLY INSULATED

### RISK OF MOULD

Adding insulated dry-lining to the external walls raises their temperature dramatically and, whilst it avoids a thermal bridge at the wall corner, it creates a serious thermal bridge at ceiling level. This is due to the dense concrete floor bridging the internal insulation layer.

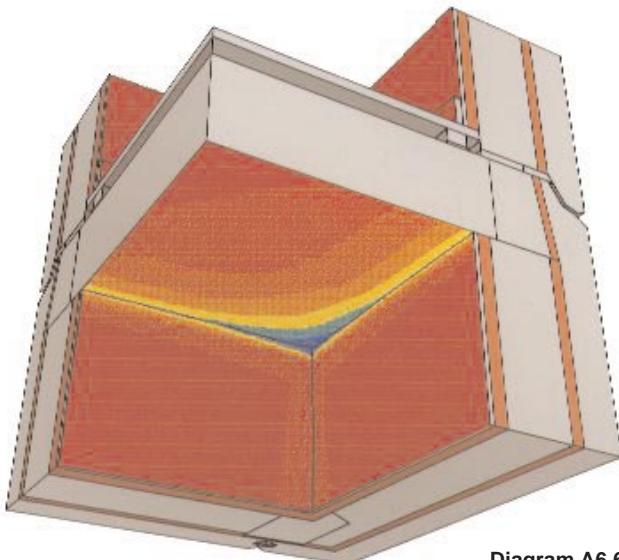


Diagram A6.6

ceiling  
insulation  
added

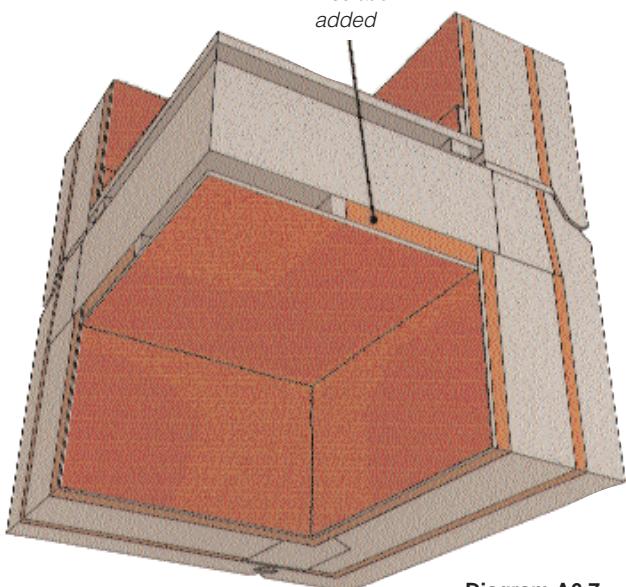


Diagram A6.7

### BEST PRACTICE

Adding a false ceiling with a 300 mm wide strip of insulation as shown in Diagram A6.7 raises the surface temperature of the ceiling to that of the walls and eliminates the risk of mould growth at the corner. A vapour control layer should be incorporated into the new ceiling to prevent moist air from the dwelling condensing on the cold concrete floor.

## B SEPARATING WALL JUNCTION – INTERNALLY INSULATED

### RISK OF MOULD

As for the external corner, adding insulated dry-lining only to the external wall creates a thermal bridge. In this case the main thermal bridges are at the junction with separating walls and floors. Unlike the external corner detail, the 'site-fixed' insulation at the panel junction has been omitted from this detail. This explains the lower surface temperature at the ceiling than in Diagram A6.6.

Below is a thermograph showing the same detail as Diagram B6.8. In this case, the vertical in-situ insulation has been omitted.

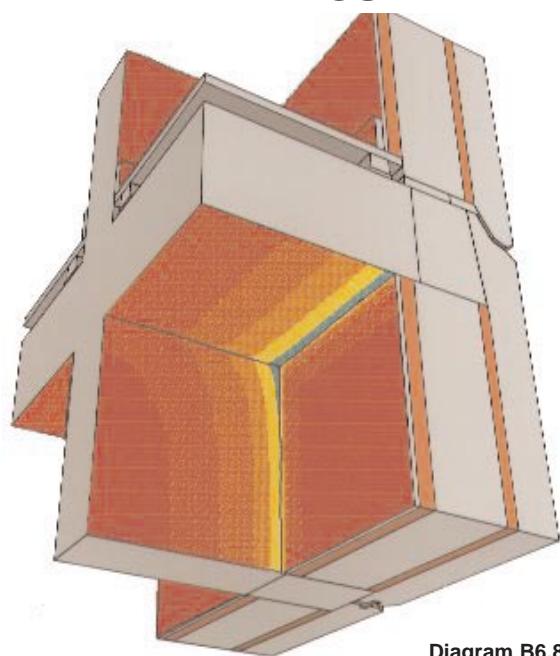
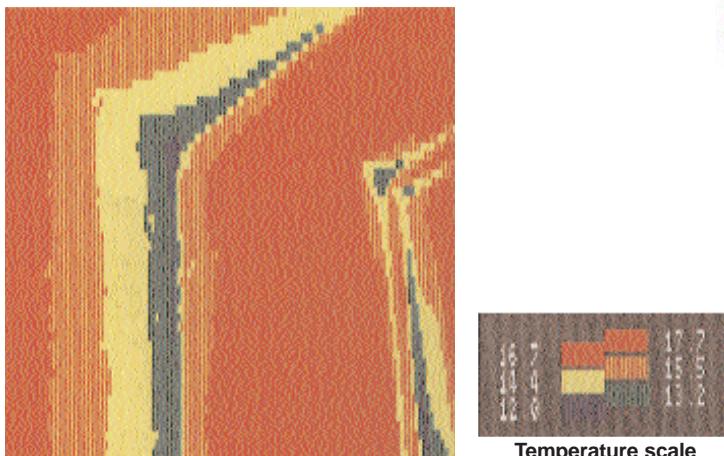


Diagram B6.8

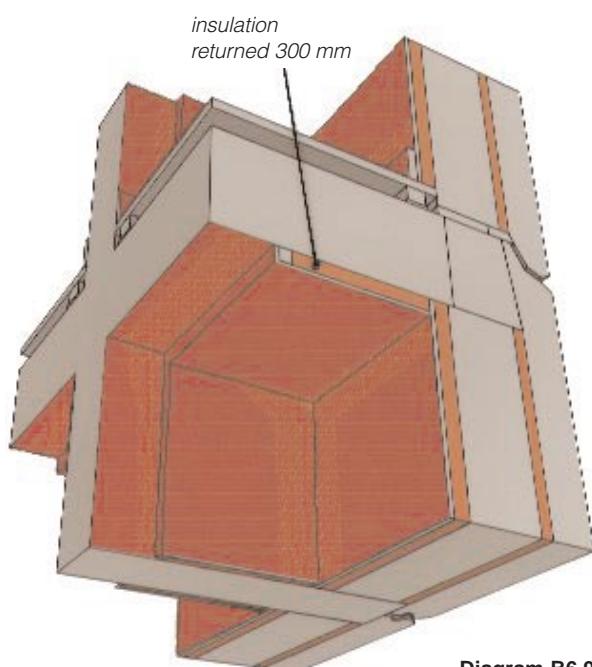
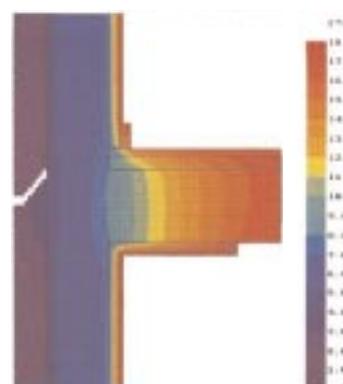


Diagram B6.9

### NO THERMAL BRIDGE

Returning the insulated dry-lining along the separating wall and ceiling reduces the risk of surface condensation in the corners. The surface most at risk from condensation then becomes the upper surface of the concrete floor, shown in the section below. Extending the length of the insulation at the ceiling level beyond 300 mm, would further lower the temperature on the upper surface of the concrete floor slab and is not recommended.

The section below shows that the coldest internal surface temperature occurs at the junction of the chipboard floor with the skirting board. Also note the cold surface of the concrete floor slab below the raised chipboard floor. This is at risk of surface condensation.



### C WINDOW JUNCTION – INTERNALLY INSULATED

#### SLIGHT RISK OF MOULD

Adding insulated dry-lining raises the temperature of the main wall area dramatically. However, it also has the effect of reducing the temperature of the inner layer of concrete. The result is that, at the junction with the window frame, the dry-lining is colder and slightly more at risk of mould growth than it would be without the insulated dry-lining. This is characteristic of using insulated dry-lining and is difficult to avoid.

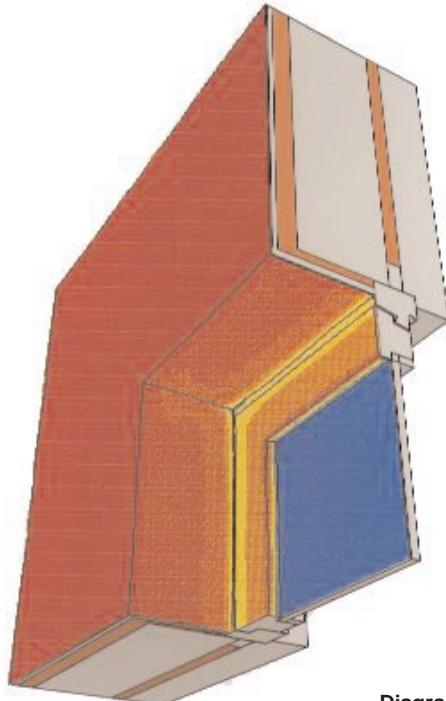
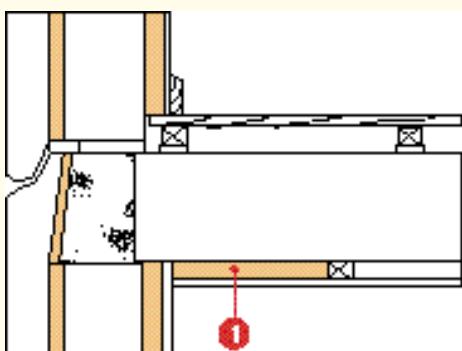


Diagram C6.10

## SUMMARY OF RECOMMENDATIONS – INTERNAL INSULATION

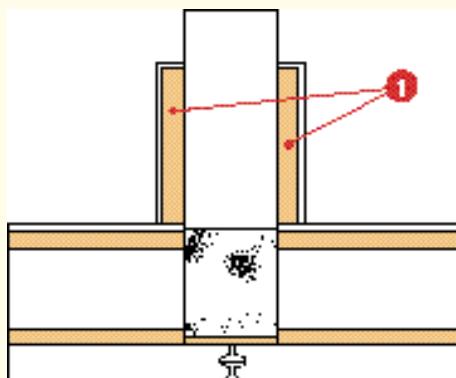
### A Upper floor junction



#### Best practice

- Specify a 300 mm strip of perimeter insulation behind a false ceiling. Incorporate a vapour control layer in the new ceiling.

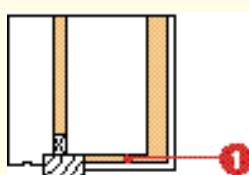
### B Separating wall junction



#### Minimum recommendations

- Return the dry-lining 1000 mm both sides of the separating wall.

### C Window junction



#### Minimum recommendations

- Return the dry-lining into the soffit and reveals at openings.

**Note:** Slight risk of mould persists with detail C6.10, above.

**Note:** Internal insulation should have a vapour check on the warm side of the insulation.

# External insulation added

The examples in this section show an external wall insulation system comprising 50 mm thick insulation with a polymer render finish. The insulant is assumed to be mineral wool with a conductivity of 0.036 W/mK. This improves the U-value of the existing wall construction from about 1.0 W/m<sup>2</sup>K to about 0.4 W/m<sup>2</sup>K.

If the external insulation is protected by rainscreen cladding instead of a render finish, the results should be similar to those shown in

this section. However, care is needed to minimise the thermal bridging effect of the steel fixing rails that are normally part of rainscreen cladding systems.

The design and installation of external insulation is a specialist job. It is strongly recommended to use an insulation system with an Agrément certificate and a specialist installer approved by the certificate holder.

## A UPPER FLOOR JUNCTION – EXTERNALLY INSULATED

### BEST PRACTICE

The 'tea cosy' effect of external insulation results in warm internal wall surfaces with no thermal bridging.

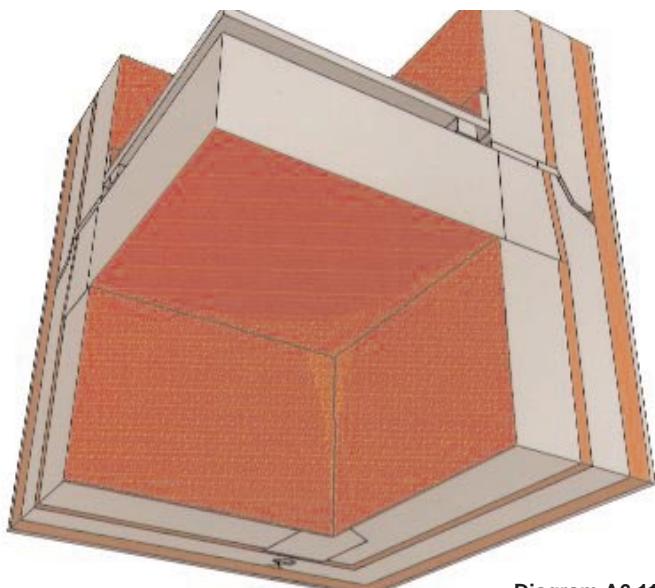


Diagram A6.11

## B SEPARATING WALL JUNCTION – EXTERNALLY INSULATED

### BEST PRACTICE

The continuity of the external insulation avoids all problems caused by the omission of the site-fixed insulation at the panel junctions. The temperature of the inner concrete layer is much warmer than it would be with internal wall insulation, resulting in a much lower risk of interstitial condensation.

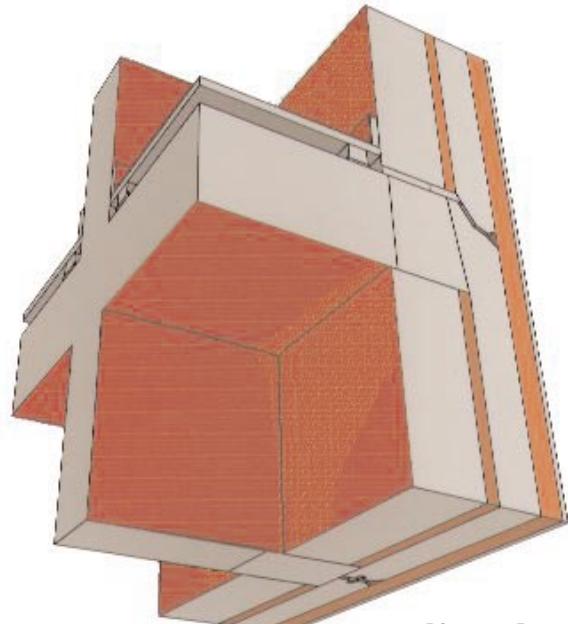


Diagram B6.12

### C WINDOW JUNCTION – EXTERNALLY INSULATED

#### BEST PRACTICE

External insulation, returned at the jamb and soffit to the window frame, keeps the dense, inner layer of concrete warm and avoids thermal bridging.

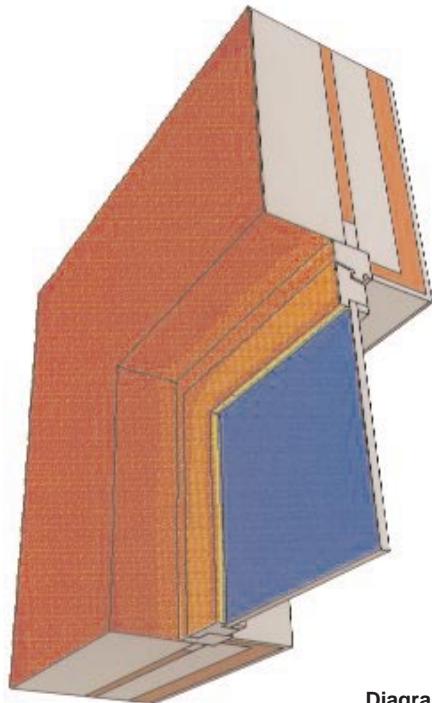
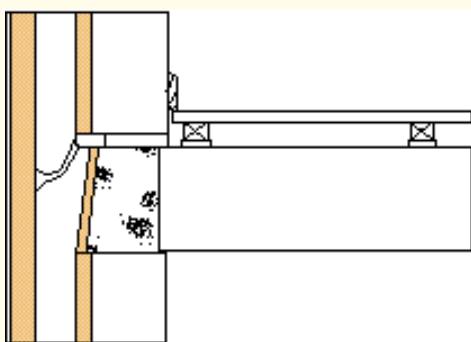


Diagram C6.13

## SUMMARY OF RECOMMENDATIONS – EXTERNAL INSULATION

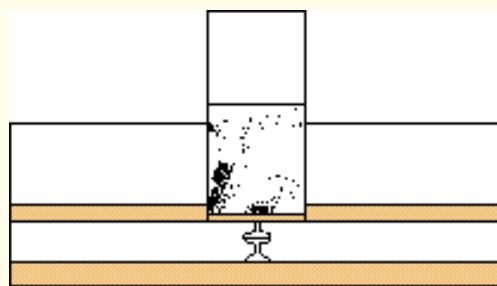
### A Upper floor junction



#### Best practice

The external wall insulation is continuous.

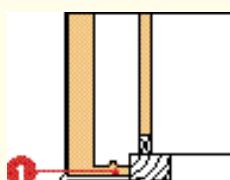
### B Separating wall junction



#### Best practice

The external wall insulation is continuous.

### C Window junction



#### Best practice

1 Return external insulation into window openings.

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